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Contents.

	PAGE
Forthcoming Events	299
Trading with Russia—II	299
The Balfour Report—III	299
Scottish T.U.C. demand Iron and Steel Inquiry	300
An Interesting Bell of Solid Silver	300
Random Shots	300
Some Interesting Moulding Jobs	301
Machining of Alloy Chilled Rolls	304
Solving a Dust-collecting Problem	305
£2,000,000 Shipbuilding Order for Scottish Yards	305
Steel Foundry Problems	306
A Note on Workshop Drawings	306
Physical Properties of Foundry Coke	307
The Relationship between the Compression and the Transverse Strength of Cast Iron	308
Scottish Iron Works to Close Down	308
An American Hot-Blast Cupola Plant	309
Progress of Electric Furnaces	311
Utilisation of Coke Breeze for Steam Boilers	312
Trade Talk	314
Personal	314
Obituary	314
Reports and Dividends	314
Iron and Steel Markets	316
Students' Corner	316

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MAY 2.

Society of Chemical Industry (Nottingham Section):—Visit to the Stanton Ironworks, Stanton.

MAY 2-3.

Iron and Steel Institute:—Annual meeting and dinner.

MAY 7.

Institute of Metals:—Nineteenth May Lecture in London. "Some Ideas about Metals," Paper by Sir Oliver Lodge, F.R.S., LL.D.

JUNE 5-15.

International Foundry Trades Exhibition, Royal Agricultural Hall, London.

Institute of British Foundrymen.

APRIL 26.

London Branch (Junior Section):—Ordinary meeting in London.

APRIL 27.

Newcastle and District Branch:—Annual general meeting, followed by a discussion on "Foundry Problems," opened by J. Shaw.

West Riding of Yorkshire Branch:—Annual general meeting at Bradford.

MAY 4.

Lancashire Branch:—Ordinary meeting at Manchester. "Some Practical Hints in Non-Ferrous Casting," Paper by A. Hapwood.

Trading with Russia.—II.

Last week we dealt with the general conditions underlying the possibilities of trading with Russia, and it is now our intention to outline the position as it affects the firms designing plant and machinery for the economic operation of foundries in general. Mr. Hooper, in his numerous conversations with the Russian authorities, was impressed with the stress constantly being laid upon the difficulty of obtaining castings for the construction of machinery of types. Apparently, a veritable famine of machinery castings exists in Russia. On inquiry, it was made reasonably clear that there was every reason to believe that no real industrial progress could be made until the country was in a position to supply itself with sound castings at an economic cost. Improvement can only be effected by the provision of modern foundry plant and equipment, and this is not merely recognised but considered as an essential by the Russian Government, so much so that they are anxious to send their highest officials over to England to examine in detail the exhibits at the forthcoming Exhibition to be held at the Agricultural Hall in June. Whether this can be arranged is obviously a matter for negotiation. It must be borne in mind that a large and important section of the community is of opinion that any temporary advantage derived from transacting business is more than discounted by the non-recognition of governmental debts and the confiscation without compensation of foreign-nationals' property. Obviously there must be ethics in business, and it certainly would be easier for everybody if diplomatic negotiations were re-established on the basis of the recognition of these two elementary principles. Unfortunately, there is in the meantime the danger of the foreign competitors firmly entrenching themselves in what can at present be considered as neutral territory.

The Balfour Report.—III.

Of the two remaining main sections of the Balfour Report that need concern us, the first refers to the effect of conditions of employment on competitive power. Dealing first with wages, the Committee finds that there has been since the war an average rise in weekly wages in this country of 70 to 75 per cent., less for skilled and "exposed" than for unskilled and sheltered trades. The labour charge in the costs of production has increased because, the Report says, the reduction in the length of the working week has not as yet been fully offset by increased productivity. Figures for other countries are not available except for the United States, where industrial wages have also risen, but where the *cost of labour has formed a diminishing percentage of the value of output*. We have constantly argued in these columns that high wages are good in themselves but only when they are economically justified by the output given. The shorter working week has in fact proved a tax on our efforts to recover our trade position, little as anybody would wish to return to it. The Committee sees no way of fixing wages other than the present one of mutual negotiation, and regards the difference between rates for "exposed" and "sheltered" industries one which will be overcome by time.

In commenting on the smaller difference in rates between skilled and unskilled workers, the Committee clearly hopes that changes in industry will enable the former to increase their wages and thus maintain a difference in favour of skilled workers which will encourage the best types of workmen to become skilled. An extension of the system of payment by results is hoped for. No encouragement is given to the idea of family allowances and the abolition of sliding scales on the basis of cost of living is anticipated.

Hours of labour have, of course, continuously diminished in Britain in spite of wage fluctuations. In twenty years prior to the war it amounted to less than one hour per week, but since it has amounted to 10 per cent., that is, from 53 to 54 to 48 or 47 per week. The Committee, however, found no desire on the part of employers to revert to the longer week, but emphasise the fact that all British interests are in favour of the international settlement of hours of labour.

A general review follows of the machinery for ensuring industrial peace, including provision inside a works such as Works Committees and outside the works by Joint Councils. Doubt is expressed whether the time is ripe for the National Industrial Council proposed by the Melchett-Turner Conference, but an Annual Conference is suggested as useful. The machinery

for ensuring industrial peace must continue to be voluntary and not State-imposed.

Unemployment insurance and its effect on the working population, including the "will to work," short time and casual employment are then discussed, and the section is completed by a study of industrial welfare and psychology and of the question of the standard of living. In forty years ending 1928, real weekly wages advanced about 16 per cent.; that is, the purchasing power has increased beyond the cost of living by this amount. No one who observes current standards among people as a whole will doubt it, and indeed it is difficult to believe that it is not larger.

Scottish T.U.C. demand Iron and Steel Inquiry.

At the Scottish Trades Union Congress held at Aberdeen, Mr. J. Walker, Glasgow, secretary of the Iron and Steel Confederation, moved a resolution calling upon the Government to set up a Royal Commission to make full inquiry into the prevailing unsatisfactory position of the industry. The resolution stated that the inquiry should have regard in particular to whether the organisation of the industry, its technical and mechanical equipment, and its financial policy were such as to enable it, other things being equal, to justify its position in the economic life of the country and in world trade; to the factors of competition arising from trade restrictions and barriers on the part of its competitors, from lower standards of wages, hours, and labour conditions in competing countries, and from subsidies direct or indirect, or other similar measures in competing countries in relation to their exports and to the cost of unemployment, not only in actual expenditure for the maintenance of the unemployed but in the waste of skill and loss of morale, and the possibilities of the capitalised value of this or its equivalent being applied productively as part of an organised scheme of dealing and industry.

Mr. Walker said that they were faced with a situation in the iron and steel industry that was very serious indeed. Since 1920 they had had an average of 21 per cent. unemployed. The price of steel in the market to-day was round about 10 per cent. more than in 1914. The employers in the industry were finding that they could not face the competition that was going on in the world to-day, and while they had 21 per cent. unemployed they had to remember this other fact—that they were producing and selling as much iron and steel to-day as they sold in the year 1914. Their capacity for production was in the region of 12,000,000 tons annually, but they could only obtain orders for a matter of 7,000,000 or 8,000,000 tons. Prior to the war two-thirds of the total production of iron and steel was sent abroad. The war had upset the situation altogether, and France was now a bigger competitor than ever it was. In the inquiry they were asking, they wanted all the factors in the situation closely examined by a committee of experts. It was essential if they were going to get the real facts of the case—where they stood in relation to other nations—that they must get an inquiry completely detached from the atmosphere of political battle. The Congress unanimously adopted the resolution.

Catalogue Received.

Slide Valves.

Messrs. Hopkinsons, Limited, of Huddersfield, have sent us their list No. 2,120, which illustrates in its 8 pages a type of slide valve which gives an uninterrupted and full-way passage through the valve for the flow of fluid equal to the bore of the pipe system.

An Interesting Bell of Solid Silver.

Below we reproduce a photograph of the solid silver bell which was presented to H.M.S. "Sussex" yesterday at Portsmouth. It had been purchased by public subscription by the people of the county of Sussex and was presented by the Lord Lieutenant of that county. It is the second largest solid silver bell yet made, the largest being presented to H.M.S. "Nelson." For its manufacture 6,500 ozs. troy of silver was used, while the finished weight is

2,500 ozs. troy. Its height is 18½ in. and the diameter 17 in. The clapper, 17 in. long, is also of solid silver with a solid silver knob of 3 in. diameter. It was cast and machined at the Deptford works of J. Stone & Company, Limited, as was also the silver bell for H.M.S. "Nelson."

American Foundrymen's Association elects New Officers.

At the annual meeting of the American Foundrymen's Association, held on April 8 at Chicago, Fred Erb, of the Erb-Joyce Foundry Company, Detroit, was elected president of the Association, N. K. B. Patch as vice-president, and H. K. Falk, F. J. Lanahan, A. Leny, D. H. Wray and S. T. Johnson as directors for three years.

Dr. Siegfried Werner, president of the Federation of German Foundry Owners, Düsseldorf, who was present at the meeting, called particular attention to the International Foundrymen's Congress, to be held in London from June 5 to 15, and stated that the fourth congress will be held at Düsseldorf in 1932.

At a joint meeting of the General Council of the Trades Union Congress, the Federation of British Industries, and the National Confederation of Employers Organisations, held at the Hotel Metropole, London, last Tuesday, it was decided to create a committee to examine the best methods for consultation and co-operation between the interests represented.

Random Shots.

The growth of advertising matter in the daily press is so stupendous that editors find considerable difficulty in filling even that fraction which they devote to so-called news. At any rate, that is the only explanation I can find for the amount of space they devote to asking you all sorts of ridiculous questions, the replies to which you never know and which would be of no earthly use to you if you did. You know the "Do you know" stunt?

* * *

We, however, refuse to be outdone. The only difference between this and the remainder is that we do not publish any answers on another page nor do we offer any prizes for correct solutions. Here goes.

DO YOU KNOW—

(1) That if all the grains of sand in a truck of moulding sand were put together end on they would reach a dickens of a long way?

(2) That if you spill a shank of metal over the ankle of a colleague he is likely to feel decidedly hurt?

(3) That fettling is proverbially a thirsty job, and that fettlers owe their long lives and robust constitutions entirely to their habit of drinking barley-water?

(4) That scrap castings are due to one of three causes: (a) bad design, (b) bad pattern-making, (c) bad pig-iron?

(5) That of all the tom-fool ideas, that of asking futile questions is the worst?

(6) But that it is good for filling space?

* * *

Some election candidates want slum reform, some want tariff reform, others want chloroform.

* * *

Voters want to know what the candidates will do if they get in, but some of the candidates want to know what they will do if they don't.

* * *

Alfred cannot be persuaded to tell either of the candidates for his constituency whether he is a free trader or a protectionist. But he keeps fowls, and he says he "wants a hole in his fence big enough to let his hens get into Jones's garden, but too small to let Jones's hens get into his garden."

* * *

Another selling story. Two rival travellers arrived in a small town to land a big order. The younger secured the only vehicle available, a porter's barrow, for his samples, and started off. The elder saw a motor-hearse in the station yard and bribed the driver to take him to his client. As he was leaving, the younger man arrived, bathed in perspiration. "No use your going in, sonny," said the elder; "I've the order in my bag." "Yes, but how did you get here?" "Did you see a motor-hearse pass you?" "Yes, of course I did." "Well, I was in it." "Great Scott," said the unsuccessful one, "I put down my barrow and took off my confounded hat to you."

* * *

Two men, strangers to each other, were lunching in a famous London restaurant. One had just finished and lighted a cigarette. The other man was struggling with his soup and said sarcastically: "I trust you don't object to my eating while you smoke." "Not at all, thanks," said the other amiably. "It's quite all right as long as I can hear the orchestra."

Marksman.

Some Interesting Moulding Jobs.

By E. Longden.

(*Continued from page* 284.)

Moulding the Top Portion.

The cope, or top side, of the mould from the joint is next proceeded with. The lifting plate A2, Fig. 8, is then located, being bedded down in loam placed on the joint. The lifting plate, A2, is made so that the casting will not close on any section whilst contracting. A minimum of 2 in. of loam is allowed between the lifting plate and the face of the mould. The various loose pieces of pattern are built in the mould during that a large opening is formed in the centre of the plate and shown covered by a smaller plate. This hole is arranged to avoid the danger of a fractured plate, which is not uncommon with a solid plate. The author recalls the breaking of a 40-ton bottom plate, which, on being made a second time with a large hole in the centre, came out quite sound. A plate so made is certainly stronger than one without a hole. Quite a long story could be given as to why such plates, when is accomplished when the top and bottom parts have again been parted.

When the mould and core are considered to be thoroughly dry, the mould is assembled in a pit sunk in the foundry floor. A cross-sectional view of the assembled mould is shown in Fig. 10, which is to a large extent self-explanatory. H2, in Fig. 10, describes the method of supporting and holding down the heavy main core. It is essential that the cast-iron stud be supported by an iron pillar built up from the bottom plate at the point of contact. The core should also have a corresponding continuity of metal support passing through the loam of the core to the metal of the grid.

After placing in the pit and firmly securing the mould with the binders, J2, and hook-bolts,

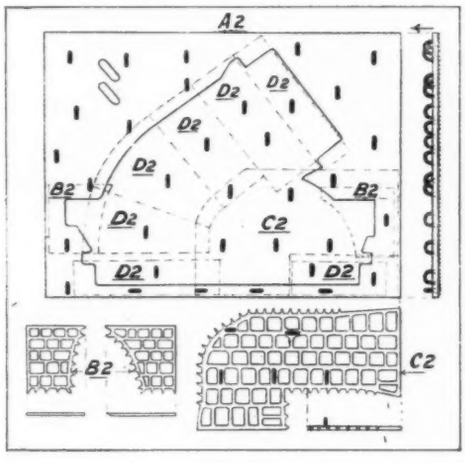


Fig. 8.

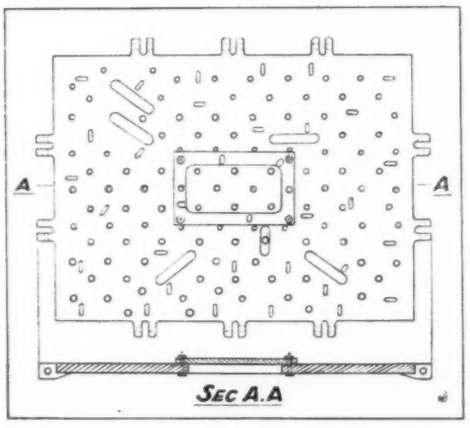


Fig. 9.

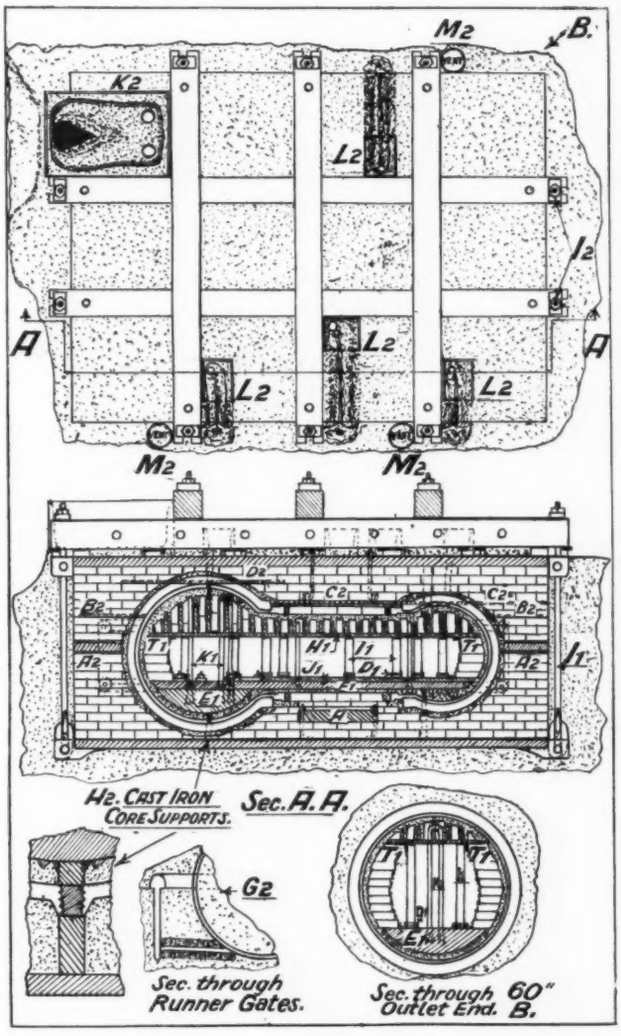


Fig. 10.

bricking, as with the bottom. Grids, B2, carry the flat surface above the feet, and C2 the "flatish" area over the body and around the bearing N and also a portion of the core-print. Grids, D2, are built in just above the top surface of the mould to help to sustain the weight of the brick work over the body and core prints. All grids, with the exception of those above the feet, contain staples to allow of bolting to the top plate, Fig. 9.

The plate, Fig. 9, is cast with a large number of holes to allow bolting up of the joint plate and the grids and riser and runner-gate openings. The openings for the runner and riser gates are elongated sufficiently to allow the use of the same tackle for more than one size of centrifugal pump body. It will also be noted cast solid, often break. One can now jump to the point where the mould has been built up, joint plate and lifting grids bolted to the top plates, runner- and riser-gates withdrawn, and locating marks for reassembly of the mould struck vertically across the joints on a prepared and smoothed loam surface.

Before breaking up the mould, the whole of the construction is given 30 to 32 hours' drying; then it is broken down to allow the finishing of the mould and core. This is done by first lifting off the top part or coping, then the core extracted, finished, and placed in the stove for drying, and the top part placed again on the bottom part to allow a moulder to trim the joints from the inside of the mould. All further finishing, blackening and locating of small cores I2, and locating the vent pipes, M2, around which plates are fixed to block off the open ends, the mould is rammed round with sand to the joint face and pouring bush, K2, and riser-gates, L2, are formed. The pouring basin, K2, is made with a strong dry-sand facing material, which is blackened and dried by an open fire. The mould is then poured with an iron of moderate strength and of approximately the following analysis:—Total carbon, 3.2; silicon, 2.0; manganese, 0.65; sulphur, 0.12; and phosphorus, 0.7 per cent.

Almost immediately after pouring labourers are posted to dig around the mould to allow of freeing the casting. In the meantime a foreman moulder, the two loam moulders, the foreman dresser and several dressers retire for tea. On their return they are able to commence the

freeing of the core. Section AA and B, Fig. 10, will indicate how the core is released. One gang, working from the direction of the outlet end, B, and another from the larger open end, section AA, proceed to knock out the bricks marked T1. When the bricks have been cleared right through from one side to the other, the cast-iron props, I1, are knocked over, after first driving out the cast-iron wedges, D1. There is thus full freedom for the casting to contract. The casting, when dressed, weighs only 7 tons, although having taken from six to seven weeks to make by two moulders and two labourers.

Pulping-Machine Jacketed-Cylinder.

Fig. 11 shows the type of casting to be described—a pulping-machine jacketed-cylinder, which is required to be in a very sound condition. of cinders were led up to the print of the core of the core. The side cores were consequently made in two pieces, divided vertically along the centre rib. Pieces were cut out of the core-box ribs to allow the core irons to pass through from one panel to the other for the purpose of strengthening the core. The core iron was, of course, of a composite nature, cast-iron bars holding a number of wrought-iron bars bent to conform to the shape of the box. Cast-iron bars were also passed through the section of metal framing the ribs and were wired to the wrought irons and were easily broken when extracting the core. The large number of bosses were chilled from the cores. These chills or denseners were wired to the core irons.

The cores were rammed up in oil sand made of large-grained washed silica sand in the proportion of one of oil to 25 of sand. Several strings vent tubes were a yard long for quite five minutes after pouring.

Moulding Details.

Fig. 13 shows at AA a sectional elevation of the assembled mould ready for pouring crown upwards. To commence moulding, the bottom box, B, is rammed up to form a flat oddside to receive the assembled pattern which sits on the ramming block as outlined when describing the pattern. The middle box parts, C, on the undersides of which is bolted the lifting plate, F, are placed into position and the mould rammed up until the top joint, O, can be formed. During the ramming of the mid-parts, bearer studs, G, are soundly located (guided by the marks of the pattern). Hook bolts pass through from the outside of the box and into the holes in the plates attached to the side of the pattern, and

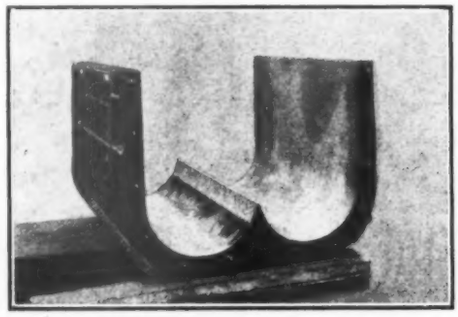


Fig. 11.

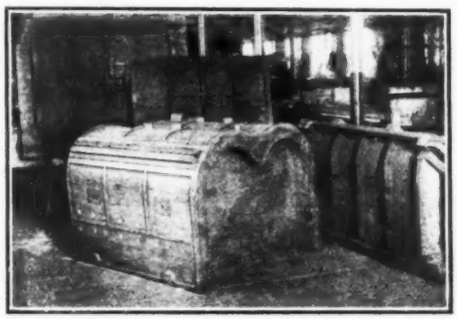


Fig. 12.

The machine, of which this casting forms the most important part, is employed to mix and break up wood pulp for various purposes. So far as the machines the author has already made are concerned, they have been used in connection with the machinery plant producing artificial silk. The material, after pulping, is passed from the machine to the adjacent and complementary hydraulic-press machinery and formed into cakes, which are subsequently passed through a chemical process by which the material is dissolved and forms what is known in the trade as the viscose solution used for the spinning of artificial silk. The capacity of the machine is 29 cub. ft., and is subjected to water pressure. As with any casting, there is more than one way to make the cylinder, but the method to be described resulted in an entirely satisfactory casting. The casting weighed close upon 2 tons, and the thinnest metal section was ¾ in.

Making the Pattern.

Before commencing to make the pattern, the moulding practice to be followed was carefully considered and the pattern made in three pieces —a top and two sides, assembled on a ramming block as shown in Fig. 12. The ramming block is shown pushed well back on the under side of the pattern sections to enable the operative to get a clear view of the outline of the pattern. Plates holding tapped holes to allow of bolting the sections of pattern to the moulding boxes were located, two of which can be seen in Fig. 12. Below these plates can be seen markings. These marks were used as guides to locate bearers to support the metal studs when coring. The core boxes were also made in three pieces and corresponded with the three sections of the pattern. The design of the core boxes is shown on the far side and behind the pattern. The print for the cores is seen in the front of the pattern. A core made out of the core box on the right of the pattern would fit into the bottom half of the core print on the side turned towards us according to the photograph.

Core-Making.

The making of the cores is made more difficult by the introduction of the strengthening ribs, which pass through from one wall of metal to the other, thereby breaking up the continuity from about 2 ft. from the bottom side. These strings of fine cinder were gathered together and were met by small tubes set in the print of the core. It may be asked why were cinders introduced into an oil-sand core? It is surprising how much gas is given off from an oil sand core, and in such cases as the casting described there would be no hesitation in aiding the exit of the huge volumes of gases formed when the metal is poured. The flames from the iron bearers, M, placed under the core prints, N. The top joint, O, does not coincide with the joint of the pattern, but with the top of the print of the core. Before taking out the two side sections of the patterns, the sand above the joint-line is cut away and subsequently made up after coring.

In ramming the top part, D, riser-gates are located on the majority of lugs and bosses, several of which are indicated by dotted lines.

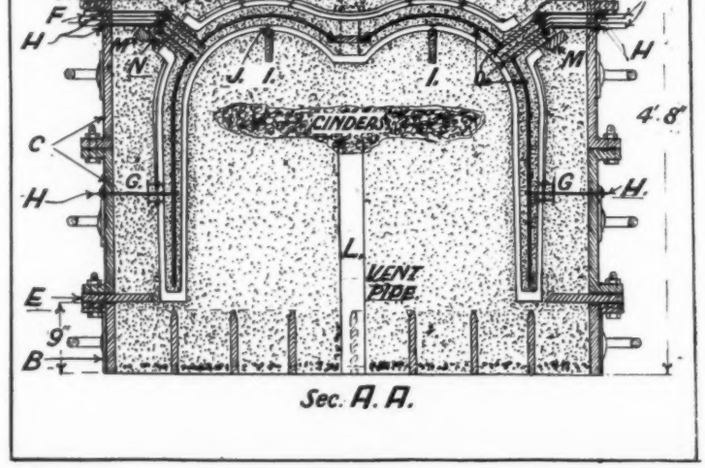


Fig. 13.

During the ramming of the top, bearers are inserted to receive the studs, K. After bolting the sections of pattern to the top and mid-parts, the mould is turned over and the mould-core and bottom part rammed up, during which operation bearer supports, I, are located to support the studs, J, and cinders, and the vent pipe, L, inserted to carry away the gases passing down from the vent holes made by the vent wire. The joint of the mould-core, or cod, conforms to the shape of the inside of the casting and is carried forward about 12 in. from the face of the casting to allow of making a well-tapered and safe joint and also to allow the arrangement of the sixteen 2-in. by ¼-in. in-gates, as shown in Fig. 14.

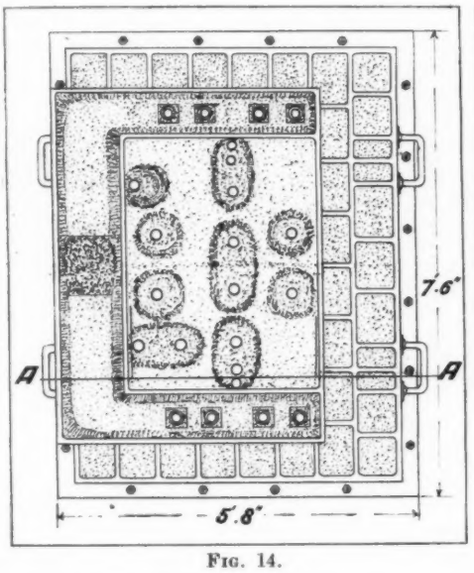


Fig. 14.

The rammed-up mould is turned back to the position required for casting. The top part, D, is first lifted off, carrying with it the top section of the pattern, and then the middle parts, H, carrying the two remaining sections of the pattern, are lifted, leaving the mould-core standing on the bottom parts. The work of finishing the mould is thus greatly facilitated. The mould is well dried, especially the bottom part holding the cod.

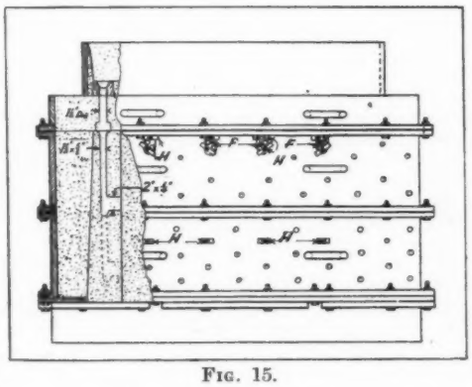


Fig. 15.

After drying, the middle parts are placed to enable the side cores to be fastened to the mould, as shown in section AA, before lowering the middle parts over the bottom part. The letters H indicate hook-bolts passing from the core through the mould to the outside of the box. The bolts in the bottom part of the mould pass through the section of metal forming the outer wall, pulling against thickness studs which rest against the metal bearer studs, G. After making good the joints of the core so that the continuity of the core section is not divided by a flash of metal the middle parts are then located on the bottom box. The top core is next placed in position, resting on the prints of the two side cores and bolted back to the sides. Vent pipes, F, are located and the core prints sealed and formed to correspond with the top joint, O, again.

The top core was too weak to avoid the use of studs under and above, but the minimum number were used by the arrangements outlined. The studs were carefully selected, samples of which were tested before using, and the hook-bolts, H, were thoroughly ground and cleaned on that part which passes through the metal section. Wherever possible it is the best practice to use clean machined or ground metal studs or chaplet stems. It is only necessary to smear the material with oil to prevent oxidation whilst waiting for the metal to be poured.

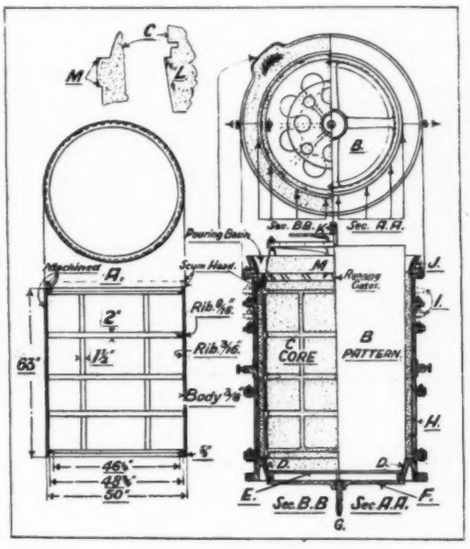


Fig. 16.

The top part, D, was not placed in position until the runner basin and riser gates had been made. The entrance to the eight down-gates were formed with dry-sand ball-cup cores, as shown in the upper part of the drawing in Fig. 13. Fig. 14 gives a plan view of the runner and riser-gate box, which is made in one piece. All risers were left open during casting.

The metal is first admitted through eight in-gates situated 6 in. from the bottom of the mould and pouring in on either side of the core by lifting first the four ball-stoppers controlling the four outside main down-gates. When about one-third of the metal has been poured, the remaining four ball-stoppers are lifted, allowing a quick and uniform filling of the mould. This scheme of gating was arranged to secure freedom from unsoundness, as would be most probable if gated from one or two points only, and also to prevent erosion of the oil-sand core.

Fig. 15 shows a part-sectional elevation of the gating and a view of the outside of the box, showing the vent pipes, F, and the hook bolts, H. The analysis of the metal poured was as follows:—Total carbon, 3.2; silicon, 1.75; manganese, 0.8; sulphur, 0.13; and phosphorus, 0.65 per cent.

Carding-Engine Cylinder.

The cylinders are the most important castings used in the construction of carding engines, which are employed for carding and cleaning cotton, wool, worsted, or waste in the textile trade. The drawing A, Fig. 16, shows the section and plan of a carding-engine cylinder weighing approximately 18 cwts. This casting is chosen to illustrate principally the design of a collapsible core-barrel, although there are other interesting features connected with the casting. The method described is the practice followed in the several textile engineering foundries for making cylinders varying from 24 in. dia. to 60 in. dia., and in lengths or widths, as described in the trade, from 40 in. to 72 in., and in weight from a little under 4 cwts. to 28 cwts. Castings 54 in. dia. and up to 108 in. in length are made by the ordinary loam-moulding practice, and weigh up to 2 tons.

The physical requirements, so far as strength is concerned, are only moderate, as the cylinders do not revolve at more than 500 revolutions per minute, but the quality of finish must be of a high order. To secure such castings without blemish requires a carefully-studied and standard practice. On looking at the sketch in Fig. 15, it will be noted that the casting is 64 in. long and 50 in. dia., yet the metal section is only $\frac{5}{8}$ in. for a $\frac{3}{4}$-in. finished casting section. In smaller sizes, from 50 in. by 40 in. downwards, the section is under $\frac{7}{16}$-in. finish.

It is much simpler to produce a cylindrical casting such as obtains in, say, gas, oil and steam engines, liners in which the section is much thicker compared with the size of the casting. There is, therefore, with carding-engine cylinders a thin section of comparatively large area, and it will be evident that any scum or dirt left in the mould or created by scabbing and erosion, or entering with the metal, will have little chance of floating into the 2-in. scum-head provided. Dirt formed by scabbing is almost invariably found adjacent to the area where it originated, or, if it enters with the metal, it will be found in the zone corresponding to the amount of metal which has been poured at the time of the entry of the scum. The head metal serves a more useful purpose in clearing the top side of gas holes, and, of course, a certain amount of dirt.

Pattern-Making Details.

B, in the half-section AA, is a sketch of the pattern, which is made either of rolled steel or cast iron, machined to allow a draft or taper of $\frac{1}{16}$ in. on the length of 72 in., and also contraction and $\frac{1}{8}$-in. machining allowance. The pattern is supported on the inside, top and bottom, by end-plates through which runs a 3-in. spindle with a hole for a shackle, as shown at K in the sketch. Great care is taken to balance the pattern so as to allow as perfect withdrawal from the sand as possible. The pattern holds a tapered print which, when located in the moulding box, sits in a machined metal print, D.

Moulding-Box Construction.

Both sections AA and BB show the design of moulding box used, and which is moulded in sections and bolted together. The moulding boxes, H, are cylindrical and perforated for venting and drying purposes, and allow 2 in. of rammed sand around the pattern. The bottom box is machined on the inside to form a metal print, as shown at D. F indicates a bar bolted to the bottom box, through which is bored a hole $\frac{1}{8}$ in. larger than the spindle, G, in the core bar, and is used as a guide to centre the core prior to it entering the tapered print, D. J is a circular runner-bush bolted to the box. I shows by dotted lines the varying depths of moulding boxes to take the varying depths of castings. E indicates the clearance allowance between the core bar and the bottom section of the moulding box.

Moulding.

The 2 in. of space is rammed with a mixture of equal parts of red and black sand and 5 per cent. of manure. The ramming is straightforward, although care must be exercised, otherwise swelling or scabbing will take place where the sand is loosely rammed. The mould is wet-blacked with a plumbago mixture and then thoroughly dried.

Core-Making.

Section BB shows the core, C, placed in the mould and sitting in the metal print, D. The horizontal ribs are formed when strickling the core, but the vertical ribs are rubbed with a special gauge, the position of which is deter-

D

mined by rotating the core until one of the holes in the top plate of the spider can be engaged by a pin. M shows the top print, which is the same diameter as the outer mould and, when lowered into position, blocks out and forms the top face of the rim of the casting. A number of spray-top drop-gates, ¼ in. by ½ in., and 16 in number, are equally spaced and arranged round the periphery of the casting. These spray-gates are formed by rubbing with a file across the print, giving them, whilst doing so, a slight tangential entry into the mould, as shown in the sketch.

The sketches M and L show the chamfering of the sharp edges of the core print, both top

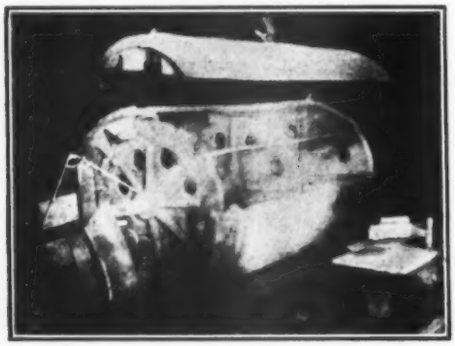


Fig. 17.

and bottom. This is done to prevent crushing of the keen edges, as will be expected when it is stated that the total weight, with core barrel, is nearly 5 tons.

Construction of Core Barrel.

Fig. 16 illustrates the drawing details for the collapsible core barrel, whilst Fig. 17 shows the constructed core barrel resting on trestles, with one of the four loose segments slung in the crane ready to lower into position and complete the barrel. The barrel is composed of a 3-in. spindle,

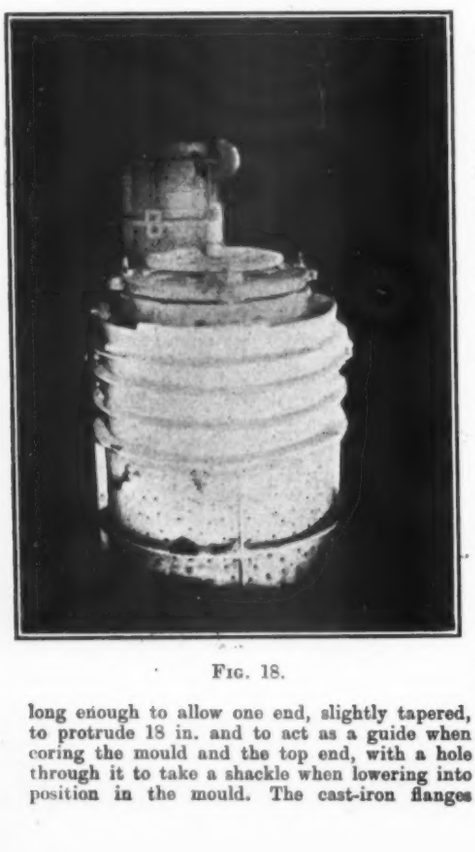


Fig. 18.

long enough to allow one end, slightly tapered, to protrude 18 in. and to act as a guide when coring the mould and the top end, with a hole through it to take a shackle when lowering into position in the mould. The cast-iron flanges are fixed firmly to the spindle and well braced with steel rods, the whole forming a spider to hold four segments, which form a complete circle when in position. The segments are easily placed into position, being located by a long pin at what will be the top end, when in position in the mould, and is secured by a cotter. The bottom end of the segment is located by a short pin, the nose of which enters a countersunk hole in the bottom flange of the spider. The segments are perforated and serrated to hold the loam, the allowance on the barrel being 1 in., excepting the tapered print, on which a minimum of loam is required.

Obviously great accuracy is required in such a core. The tapered print must also close exactly into the metal print, otherwise leakage of metal will occur. The core is swept up on permanent iron trestles, the spindle revolving on rollers. The position of the metal strickle is also permanent, and is held into its correct place by locating pins.

Fig. 18 shows the mould ready for casting, with the core lowered into its place. This photograph will also serve to illustrate the act of withdrawing the spider after casting. The casting is relieved about five minutes after pouring by knocking out the cotters securing the segments to the spider and withdrawing the latter with the crane in the manner shown in the photograph. After withdrawing the spider the two small segments are knocked forward by a bar, they being held in the crane slings whilst doing so. Thus, all four segments are withdrawn from the inside of the casting.

Very often the spider is placed on the trestles, the segments assembled thereon, and the loam swept on the barrel while still warm. If this is done, the core can be slipped up twenty minutes after the roughing coat. The metal poured into such castings is of a medium quality, and of the following composition:—Total carbon, 3.5; silicon, 2.0; manganese, 0.5; sulphur, 0.15; and phosphorus, 0.8 per cent.

Machining of Alloy Chilled Rolls.*

Recent Development.

About 25 years ago the rolls used for structural shapes, rails and other large sections generally were made of sand iron; in some cases a chilling ring was used in the finishing grooves of these rolls. Steel and nickel steel rolls were used for blooming or cogging mills and for some shapes where extreme strength was needed. Rod and small merchant mills used steel rolls in their roughing stands and mild and medium-chilled iron rolls for the finishing stands. Plate and sheet mills employed mild and medium-chilled iron rolls about 55 to 65 scleroscope; cold rolls for sheet mills were chilled iron about 70 to sometimes as high as 80 scleroscope.

The tools used for turning rolls at this time were practically all straight high-carbon tool steel, and some few brands contained a small percentage of tungsten. Some of these steels made excellent finishing tools, and to this day retain their standing as finishing steel, especially for chilled iron rolls.

High-Speed Steel Introduced.

Several years later came self-hardening tool steel, closely followed by high-speed steel, but about the same time came carbon-alloy rolls of chromium and nickel and a few other similar alloy-steel rolls. These rolls were made in several grades from soft, with 1.40 to 1.60 per cent. carbon, to hard rolls, with 2.10 to 2.30 per cent. carbon. The sand-iron and chilled-iron rolls have remained much the same for a period of about 20 years. The alloy-steel rolls were much harder to cut, but the average high-speed steel took care of these rolls nicely.

According to data compiled by a large rolling-mill-machinery builder, the cutting speeds used on lathes varies wide in different shops. What is considered good average cutting speed in one shop is often considered too slow or too fast in another shop. It also varies on different classes of work. Some shops are of opinion that the proper speed for cutting chilled rolls 35 to 38 in. per min., while others go as high as 70 to 80 in. per min. The following are good average cutting speeds:—

Type of rolls.	In. per min.
Sand iron or steel	300 to 336
Alloy (hard, 2.40 per cent. carbon)	55 to 60
Chilled	48 to 50

The foregoing cutting speeds are high for sand iron and steel rolls, and are rarely used except in roll-maker's foundry roll shops, where the turners are paid piece-work. The piece-work system of turning rolls is used exclusively by the roll-makers, as the work consists largely of turning necks and rough body turning, and there are few other shops where tool steel receives the same abuse.

About two years ago roll-makers started to make iron rolls containing chromium and molybdenum, and later, some with a small percentage of nickel in addition to the other alloys. These alloys make a close grain structure, and when cast in sand moulds are known as special grain rolls; when cast in heavy iron chilling rings, they are known as special alloy chilled iron rolls. They have greater depth of chill, surface wearing qualities of the old time chilled rolls and strength that almost may be compared to steel. The average hardness of these rolls is from 70 to 75 scleroscope. A few of these alloy rolls have been made for cold rolling as hard as 90 scleroscope, but above 80 there is no steel that will cut them and they must be ground.

Special alloy-chilled-iron rolls of 70 to 75 scleroscope are replacing many of the old type of iron rolls, and in some cases, steel rolls, due to their strength and wearing qualities. They are exceptionally hard turning, having more of an abrasive action on the tools than the old type chilled-iron rolls. The large number of these rolls in use to-day have increased the roll-turning time and costs when using ordinary high-speed steel. Results obtained through the use of a recently developed high-speed steel for roll turning have proved that such a steel not only can bring roll turning costs back where they were before the introduction of alloyed-iron rolls but also reduce the costs of former years.

The production engineer of a large concern manufacturing rolls points out some interesting figures on comparative tool performance. Tools made from the new steel, called "circle C," keep their edge throughout the machining of five to six rolls of average size. With the ordinary high-speed tool steels formerly used, tools were ground at least once after each roll, and it was found necessary at times to remove a tool and regrind it before a single roll could be finished. After five months' service, the tools made of special steel have not been reforged, and their present condition indicates that they will not require forging for from one to three months more. A life of six months per forging may reasonably be expected. With the former tools, reforging was done at least once a month.

Turning Tools are Reforged.

The tools used for this work are of sufficient length to allow for six reforgings before they get too short for further service. On this basis the usual tool life with regular high-speed tool steels was seven months, whereas the special steel indicates a probable life of several years. Owing to the fact that tools made of the special steel require much less frequent grinding and because they may be forced without appreciable harm, the lathe hands have been enabled to increase their production materially. With rolls on which a production of four per day formerly was considered good practice, the men are now producing six.

* From the "Iron Trade Review."

Solving a Dust-Collecting Problem.

On a recent visit to Glasgow our representative was afforded the opportunity of inspecting the Argus Foundry at Thornliebank, one of the most interesting metallurgical concerns in Great Britain. One of the most important activities of the directorate is the provision of a well-lit, adequately-ventilated and heated shop, so as to ensure for the operatives a maximum of comfort. It is established beyond question, that the provision of efficient lighting and pure air is, sentiment and sanitation apart, a paying proposition.

As is the case with many foundries, the most troublesome piece of apparatus for the creation of dust is the sand blast plant, whilst the provision of a cyclone dust collector is not invariably the solution of the problem. The plant at the Argus Foundry consists of two Tilghman chambers of the usual type, and actually two dust separation plants of a new design, one for each chamber, have been installed with complete success. For its functioning, a connection is made to the top of the shot separator into which the sand and shot are drawn through the floor of the sand blast chamber. This separator is, of course, part and parcel of the Tilghman apparatus, and is so designed to separate the sand and shot. The whole of the suction, which is under a water gauge of 5 in., is supplied by a Spencer & Halstead special narrow-width high-pressure dust fan, direct coupled to a 15-h.p. motor, the actual power absorbed being 12 h.p.

The sand is drawn off the shot separator, through the fan, and is discharged into a patented dust filter, housed in a light steel framework building outside the foundry. Exigencies of space precluded its installation inside the foundry; where this can be effected a skeleton framework is sufficient, as it is only weather considerations which demand the construction of building to protect the filter bags from atmospheric attack.

The firm of Spencer & Halstead being located in Ossett, in Yorkshire, have for many years tackled various problems in connection with the local textile industry, and this association has enabled them to find an eminently suitable canvas material for the construction of the filter bags, and a claim for 100 per cent. efficiency is made.

The dust-laden air is introduced tangentially into a circular chamber 8 ft. diameter by 1 foot deep. Into the bottom disc of this chamber are let a number of spigots on to which the tubes are hung. The bottom ends of the tubes are connected with corresponding spigots set in the top disc of a circular hopper, also 8 ft. in diameter. This hopper is fitted with a rotary air lock, which enables the dust to be emptied whilst the fan is running. Where, as in some cases, an ordinary damper is fitted in the place of an air lock, then the fan must be stopped before the dust is emptied.

An interesting feature of this filter is the shape of the top spigots, which are straight for a sufficient length to enable a clip to be placed round the tube and spigot, but after that, some 3 inches of straight, the spigot becomes tapered for approximately the same length as it is in diameter. This will have the effect of injecting the dust down the centre of the tube, which not only prevents the dust from clinging inside the tube, but eliminates very largely any tendency to the rapid wear of the tubes. Deterioration would be rapid if the dust were allowed to impinge straight into the canvas at the point where the straight of the spigot ends. This arrangement is clearly shown in Fig. 3. The tangential introduction of the dust causes centrifugal motion to be set up in the top circular chamber, which causes each tube to receive an equal quantity of dust. There is only one tube in the centre, whilst there are tubes the whole way round the periphery, with additional rings of tubes of decreasing number as the centre is approached. We are assured by the management of the Argus Foundry that the plant is giving the utmost satisfaction, and we desire to extend our thanks to Mr. N. McManus, its managing director, for the help accorded to us in the preparation of this article.

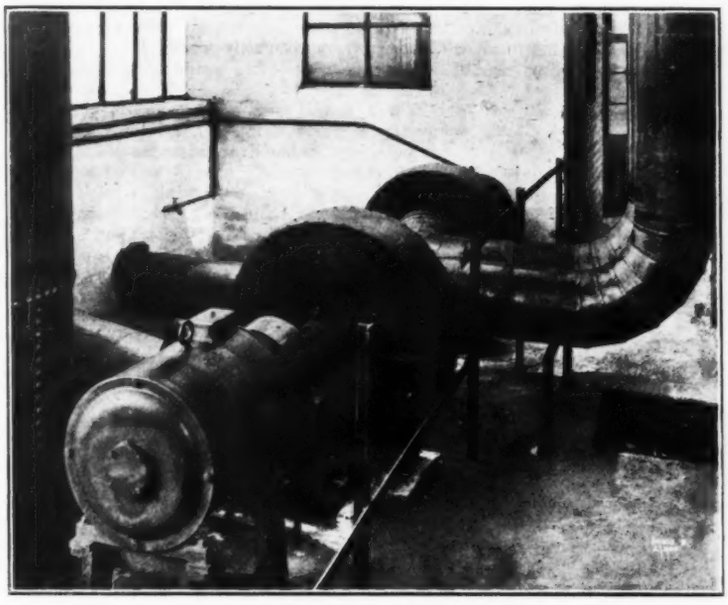


Fig. 1.—The Dust-collecting Plant installed at the Argus Foundry.

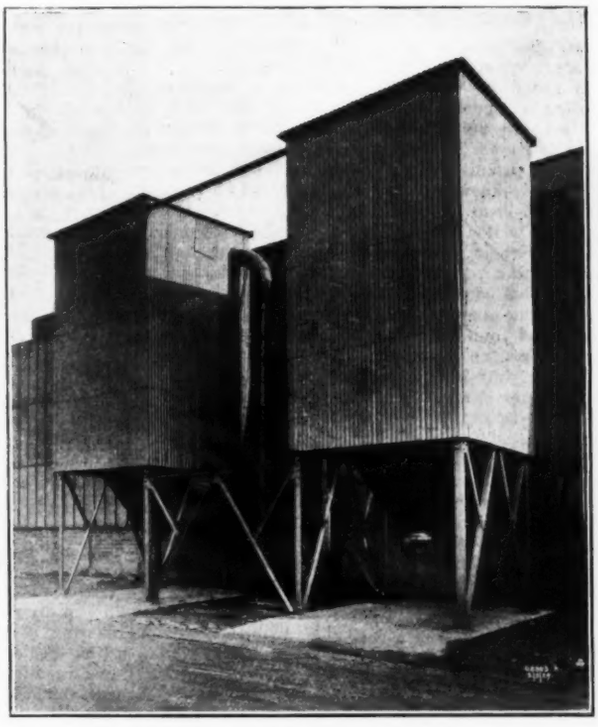


Fig. 2.—The Housing of the Dust-Filter outside the Argus Foundry.

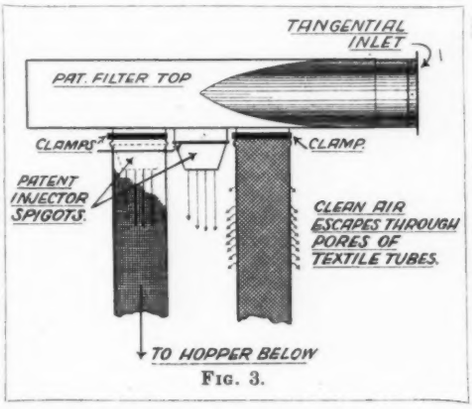


Fig. 3.

£2,000,000 Shipbuilding Order for Scottish Yards.

Greenock will benefit substantially from orders which have been placed with two Scottish shipbuilding firms for 18 passenger and cargo boats by the Cia de Nav. Lloyd Brasileiro, of Rio de Janeiro. It is reported that the orders involve £2,000,000 and that they have been divided between Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, and the Burntisland Shipbuilding Company, Limited, Burntisland—twelve to the former and six to the latter. The Greenock firm are to supply the machinery for the vessels to be constructed in their yard, and it is considered possible that orders may come to the Clyde for the machinery of the vessels to be built at the Forth yard.

A party of British business men, headed by Lord Ebbisham, President of the Federation of British Industries, is shortly to leave London on a visit to Sweden, made as a return trip to that of a representative body of Swedish industrialists who recently conferred with members of the Federation in London.

Steel Foundry Problems*

By G. E. Wells.

When, at a purchaser's works, machining operations disclose defects in a steel casting, a decision must be made as to whether a repair be effected or a replacement made. The latter is the more costly operation and, what is often more important, entails a much greater delay, so that a repair is generally decided upon if the nature of the defect permits of this method of treatment.

Normally the casting is returned to the maker who carries out the rectification in his own works. Broadly speaking, this is the most satisfactory way of dealing with the job.

On the other hand, the question of urgency is often of paramount importance, the probability being that the purchaser needs to reduce as much as possible an inevitable delay arising out of a promise which he himself has made, although he knew perhaps, that it might be very difficult to keep it when he took the order. He therefore writes to the maker of the casting, stating that it is defective, and that he has carried out a repair for which a charge will be made in due course. He may even go so far as to state the amount.

The steel founder naturally tells the customer that he has no objection to his carrying out the repair, but he may add that in his opinion the customer should then be responsible for the cost. It is at this point that the argument commences. The final settlement depends to some extent on the mentality of the two disputants, but it often happens that the buyer gets his own way not because the steel founder believes himself in the wrong, but because he feels it politic to give way rather than to prejudice further business at a time when orders are few and far between. It is obvious, however, that such a question should be settled on its merits rather than on the principle of "might is right." Let us now, therefore, examine the pros and cons with a view to arriving at an equitable and reasonable solution.

Experience the School of Correction.

The buyer undoubtedly has the whip hand, as he can deduct the cost of the repair from his remittance when paying for the casting, leaving the manufacturer to accept the situation or institute proceedings for recovery, thereby closing the account. Let us, however, try to understand the steel founder's point of view. He is engaged in the manufacture of an article difficult to produce satisfactorily, and success is largely dependent on his experience, which teaches him to avoid making the same mistake twice. How then is he to avoid repeating his errors if he cannot get a sight of the defective casting? A sketch, even when made by an expert, will almost invariably fail to convey more than a rough idea of the nature of the defect; rarely, indeed, will it serve to indicate the cause of the trouble. Even a visit by the founder himself may be inconclusive, as the origin of a defect is often very difficult to discover, and can only be found after a concerted examination by a number of the men engaged in the production of the casting.

In many cases, therefore, it is only fair to the founder that defective castings should be returned to him in order that he may enrich his knowledge and increase his experience to his own and his customer's advantage in the future. If, however, the customer does his own repairs, the founder does not get an opportunity to effect this valuable increase in knowledge, and in these circumstances it seems illogical that he should be expected to assume responsibility for the cost of the work carried out by the user. When the latter decided to execute the repair he was suiting his own convenience, his plea being that he was saving time. But time is money, and the amount gained in this way should be set off against the other expenditure. Further, it must be pointed out that the manufacture of steel castings is not an exact science, and it is therefore arguable that the user should not expect an absolutely perfect article. Rather should he make allowance for a certain expenditure on rectification, counting this as a manufacturing charge just as he allows a margin in many other directions in making up an estimate. Defects of a slight order, generally merely eyesores, should be made good by him at his own expense, the only charges which are passed on to the founder being those incurred in carrying out major repairs and then only after agreement between the two parties. To sum up, the most equitable position would appear to be as follows:—(1) All defective castings requiring repair should be returned to the founder; (2) the user may carry out this work himself, but only at his own expense and responsibility, and (3) all other things being equal, the founder whose castings need the least welding should get the bulk of the orders.

* From the "Edgar Allen News." The author is a director of Messrs. Edgar Allen & Company, Limited.

A Note on Workshop Drawings.

By J. McLachlan.

No workshop in an engineering works appreciates good blue prints or tracings as does the patternshop. In the foundry, moulders and coremakers need only refer—if patterns and coreboxes are not sufficient—to the full-size workshop drawing that has been set out by the patternmaker, but it is very different in the patternshop when accuracy depends almost entirely on the draughtsman's work. Digressing, it may be admissible to express surprise that the metric system has made so little progress in engineering. It is the simpler system, and the writer used the metric rule nearly thirty years ago, and many engineers then thought it would rapidly oust the standard rule. In heavy engineering it has made no headway and, even in works specialising in light work it is not, by any means, universally used. Whichever method of measurement is adopted, however, has actually nothing to do with the accuracy of drawings or the difficulties attendant on setting down work to full size from a scale drawing.

A patternshop knows whether it can depend on the drawing office for accurate work. If blue prints are received that have many alterations, and from which many important dimensions are omitted, the patternmaker before he actually starts his work has to scrutinise the drawing carefully. Hours are frequently spent checking dimensions, work that should be unnecessary. It is very seldom nowadays that tracings are sent down to the patternshop, and rarely indeed do original drawings come down. Original drawings are never welcome in workshops, and blue prints—when they are good prints—are more suitable for workshop conditions than tracings. In nine cases out of ten bad prints are better than tracings.

This question of good and bad drawings was brought to the writer's notice recently by an article in an engineering journal in which the statement was made that, despite the tremendous importance of blue prints in every branch of industry, it is amazing to find how little regard is paid by the draughtsman or designer to legibility. This statement ought to be qualified because it is unjust to make such a statement about draughtsmen as a body. There are large works in which it is very unusual for a complaint to be made about drawings. In cases where a foreman patternmaker simply pesters the drawing office for preliminary drawings to get men started on a job he cannot justly complain if lines and dimensions are almost illegible and errors occur.

It is simply foolish to send illegible drawings into the workshops and especially the patternshop which can so easily make mistakes that will involve foundry costs, machine and fitting shop charges before they are discovered. Even if mistakes are detected at the marking-off table before any machining has been done on them the losses up to that point are heavy. A slovenly draughtsman may send down a drawing from which many dimensions are omitted. The patternmaker may return it frequently to have these dimensions inserted or, to prevent delay, he will "scale" the measurements. Anyone with experience knows how difficult it is to "scale" a blue print with accuracy, especially if the drawing has been made to a small scale. For work that is of an accurate kind especially, "scaling" should be ruled out. If, because of peculiar circumstances, such as distance between the drawing office and the patternshop, measurements have to be "scaled," care should be taken to insert them, and they should be confirmed and initialled by the draughtsman before the pattern and coreboxes are sent to the foundry. In small works draughtsmen and patternmakers may be in close touch with each other, and mistakes are more easily rectified than in large works where only the heads of the departments meet.

There are, broadly, two classes of drawings sent into patternshops, detail and arrangement drawings. Some draughtsmen will expect the patternshop to make pipe connections or valves from an arrangement drawing, whereas its only value is when "handing" bosses, branches, etc., is necessary, as for the port and starboard engines of a ship. Sometimes an arrangement drawing is also useful as indicating machined surfaces. The detail drawing should be as clear and accurate as it can be made, and machined surfaces should be indicated. It should rarely be necessary for the patternmaker to suggest modifications because of foundry difficulties or to simplify machining operations.

Scrap views showing intricate cores are not employed to the extent they might be. It is often extremely difficult, indeed it may be nearly impossible, to show awkward shapes on the large views, but what is required may be conveyed clearly by a scrap view or a small portion of the casting drawn to a comparatively large scale.

The Patternmaker as a Draughtsman.

In repair shops, patternmakers often make their own drawings of valves, gears, etc., using recognised formula for obtaining dimensions or, alternately, making sketches from old castings and then setting down the work to full size on a shop drawing board. In many cases this practice is more satisfactory than when a draughtsman is on the job. The patternmaker, if he obtains information at first hand about a casting that has failed in service, knows what allowances to make to ensure that failure will not recur. Obtaining dimensions from an old casting is not pleasant work, and it is very seldom indeed that it will be done by a draughtsman. There are important lessons to be learnt from an old casting, and patternmakers know what to look for.

In the article previously referred to, it was very truly stated that if a draughtsman introduces a tracing from which an illegible blue print will be produced, then although he is saving his own time he is wasting the time of probably a dozen others. What is never excusable is for a draughtsman to alter a drawing when a job is under construction without notifying the patternmaker, although we have known this to be done. Even on the most intricate work, before pattern and coreboxes are completed, practically every dimension on a drawing will be memorised and an alteration will be quickly discovered. Much time would be saved in pattern shops if, before any job was started, dimensions on the various views were compared in order to trace inaccuracies. In setting down work such comparison of dimensions will involve more time than the simple copying of a view, but, just as in the case of the drawing office, a few hours extra spent at a drawing board may mean as many days saved afterwards.

Physical Properties of Foundry Coke.

By Prof. H. V. A. Briscoe, D.Sc.

At a joint meeting of the Newcastle and Middlesbrough Branches, at which Mr. C. Gresty presided, Professor H. V. A. Briscoe, D.Sc., of Armstrong College, Newcastle-upon-Tyne, read the following Paper on "The Physical Properties of Foundry Coke":—

Northern Coke Research Committee.

The investigations which provide the data to be considered, were undertaken at the instigation, chiefly, of Sir William J. Larke and Mr. E. C. Evans, of the National Federation of Iron and Steel Manufacturers. As a result of their suggestions, the Northern Coke Research Committee was constituted in November, 1926, and since then has been actively at work. The Committee consists largely of representatives of trade and technical associations interested in the production or use of coke; amongst them are British Cast Iron Research Association, the Cleveland Ironmasters', West Coast Blast Furnace Owners', Durham Coal Owners' and Cumberland Coal Owners' Associations, the Coke Oven Managers' Association, the Institution of Gas Engineers, the Institute of Mining and Mechanical Engineers, and the Midland and Scottish Coke Research Committees. There are also representatives of certain firms—the South Metropolitan Gas Company, the Newcastle and Gateshead Gas Company, and Messrs. Synthetic and Ammonia and Nitrates, Limited—and representatives of Armstrong College. The research is in the able hands of Dr. W. T. K. Braunholtz, who, as Senior Chemist, works in a laboratory provided and largely equipped by Armstrong College, under the direction of Professor Granville Poole and the lecturer.

The Research Committee is a strongly representative one, each association and firm represented having endeavoured to appoint a member who has real knowledge of fuel problems and understanding of research, and, in consequence of this, the findings of the Committee with regard to the properties of coke merit serious consideration. It is not likely to pass for publication any findings of the laboratory unless it is satisfied that they are sound and trustworthy.

Relation between Strength and Combustion.

Foundrymen are very much interested in coke from a strictly limited but commercially important standpoint. They use it primarily for the sake of its property of reacting with oxygen to form carbon dioxide and generate heat. They are also interested, it is true, in the composition of coke as regards its sulphur and phosphorus content, but the chemical estimation of these constituents is so well understood that they need not be further discussed here. It is only just being discovered, however, how to estimate the worth of coke from the standpoint of its combustion.

Foremost among the measurable physical properties of coke is its hardness or strength, which is important because it is indirectly related to its practical utility in burning. It has been thought that the strength of coke is important in itself, but there can be very little in that aspect of the matter. The pressure on coke due to the burden, even in a blast furnace, is only about 3 or 4 kgs. per sq. cm. Taking ordinary metallurgical cokes, the crushing strength measured on a cube or cylinder by the ordinary pressure test is of the order of 100 to 200 kilos per sq. cm. Therefore mere physical strength of coke as such is not important, but it appears to be a useful indication of the value of coke because, in some way not yet clearly understood, it is correlated with the ability of coke to burn to carbon dioxide instead of to carbon monoxide.

Shatter and Trommel Tests.

The mechanical strength of coke is measured by two tests, the shatter test and the trommel or drum test. In the shatter test a 50-lb. sample of coke is dropped four times from a height of 6 ft. on to an iron plate. The shattered material is handled through square-meshed sieves, and what remains on the 2-in. sieve is taken as the measure of the strength, the "shatter index." The Northern Coke Research Committee's shatter test apparatus has been evolved after study of other people's apparatus, and has proved to be very convenient. The iron bedplate is surrounded by a box, the front of which hinges down to facilitate picking up the shattered coke. The guides are clear of the bedplate, and the box, 30 in. square, hung between them by a counter-weighted wire rope, has a hinged bottom in two halves, which are conveniently released by withdrawing a catch. The design has been published, and the Committee would be glad to supply the working drawings to anyone desiring to set up a shatter test apparatus.

In the trommel test, the coke is put into a drum having angle-brackets fixed round the circumference inside, and the drum is rotated so that the angles carry the coke up and drop it repeatedly. For the standard (Continental or "Micum") test, 50 kgs. of coke is used in a drum 1 metre long and 1 metre dia., which is given 100 revolutions in four minutes. It is important to standardise these particulars, because, evidently, the number of revolutions has a considerable effect on the number of blows the coke gets. To estimate the results the coke is shaken on round-hole sieves in millimetre sizes, the percentage remaining on the 40-mm. sieve being taken as the "Trommel Index."

Variations of the Tests.

Numerous tests have been made of the variations of both the shatter and drum tests. It has been found that the shatter test is but little affected by variations in the size of the box or sample: the same result is obtained by working with 25 lbs. of coke instead of 50 lbs., and the size of the box makes little difference, although a box smaller than 30 in. square gives rather higher shatter test indices for poorer cokes. For this reason the 30-in. square box is the better test and has been adopted in preference to the so-called American box, which is 28 in. by 18 in. The shatter test of coke is increased by previous shattering, and this effect is especially marked with a soft coke.

An important point which has been discovered about the drum test is that it can be adapted to work with a smaller quantity of coke than 50 kgs. By taking a drum of the standard diameter, but ½-metre instead of 1 metre long, the same result is obtained with half the quantity of coke: 50 lbs. in a half-trommel is a serviceable test.

Both tests are considerably used on a large scale, firstly in the selection and purchase of coke, and secondly, in the control of coke production and furnace operations. In recent investigations by the Northern Coke Research Committee, the shatter and drum tests have been carefully compared, and it has been found that for a series of cokes the shatter and trommel indices are parallel and that the fines in the two tests corresponded very closely. This means, clearly, that the breakage of the coke in both tests is effected essentially in the same manner. The drum test is, in fact, a modified shatter test in which a number of short drops are substituted for the four 6-ft. drops. The general correspondence between the two results is obvious from the data shown, and the divergencies are little, if any, greater than the error of experiment. On a graph showing the results of a series of cokes in both tests the parallelism is clearly shown, whence it is concluded that the shatter test and the trommel test both measure breakage by impact. Photographs illustrated that coke from a trommel was rounded and rather like that which had been through a furnace, yet it seems certain that the results of the trommel tests are little affected by abrasion.

Without detracting in any way from the importance of the shatter test, it is important to recognise that it is not strictly a measure of the ability of coke to burn efficiently: this is evident when one considers, for example, that the shatter index, being increased by previous shattering, depends on the treatment the coke has received prior to the test: while this, evidently, cannot affect its chemical nature.

Visual Examination of Coke.

Other physical properties of coke are chiefly of interest for the light they throw on the shatter test. The micro-structure of coke is well shown by sections prepared, according to Rose's method, by embedding coke in plaster of paris, cutting the blocks longitudinally and transversely, grinding the cut surfaces and filling them in with plaster. A series of photographs illustrate how such sections showed the nature and extent of the fissuring of the cokes, the size and distribution of ash, and the general nature of the pore-structure.

A good deal of information can be obtained from X-ray photographs of coke, in which the coke substance appears translucent, while the ash is opaque. These show very well the nature and distribution of ash and give some information about fissuring. It is even possible to take stereo-radiographs of coke which, when viewed in a suitable stereoscope, show a solid picture of the coke as a translucent jelly, in which particles of ash and fissures can be clearly seen in three dimensions. An example of such a stereo-radiograph was demonstrated.

Carbonisation.

A great deal of work has been done on the effect of carbonising conditions on coke properties, and as a result of the work of the Coke Research Committees in general, much information is available as to how the several measurable properties of coke are influenced by the nature of the coal and the treatment to which it is subjected in carbonisation. Yet very little is known of the correlation of these properties with the behaviour of coke in actual use in furnaces. Therefore means must be found of observing and recording in figures *how cokes burn*. Two fairly obvious characteristics which may be measured are the ignition-temperature and the maximum temperature attained, both observed under standard conditions of air supply. Another very significant fact is the *type* of combustion as indicated by analysis of the waste gases. As is well known, carbon may burn either to the dioxide or the monoxide: the former reaction gives roughly three times as much heat as the latter, so that in furnaces, where the maximum possible evolution of heat is desired, one requires much carbon dioxide and as little carbon monoxide formed as possible. The ideal would be a coke which would produce all carbon dioxide and no monoxide: this is never obtained, but some cokes give a higher CO_2:CO ratio than others, and in consequence are more efficient in the furnace.

Combustibility Test.

The combustibility test of the Northern Coke Research Committee was specifically designed to investigate these points, and has already proved its worth, and full details of the test in its original form have been published in "Fuel in Science and Practice," 1928, vol. 7, p. 100. Recently the test has been improved by using a single movable thermocouple traversing the full height of the fuel-bed and by heating the charge initially by an internal, instead of an external,

electrical heater. The essential features of the test are as follows:—A bed of coke, carefully sampled and graded 5-10 mesh I.M.M., is supported on a layer of broken earthenware in a 2-in. dia. vertical silica tube. Below the earthenware is a layer of nickel-shot, in which the electrical heating-unit is embedded. Precisely 0.2 cub. ft. of clean, dry air is supplied per minute to the lower end of the tube and the heater is turned on, causing a steady rise in the temperature of air and of the fuel-bed. Then at a certain temperature (the ignition-temperature) the fuel ignites and begins to heat up rapidly, soon attaining a steady maximum of 1,200 deg. C., and gas analyses are made to ascertain the CO_2:CO ratio and rate of carbon consumption. Reproducible and characteristic figures for ignition-temperature, maximum temperature and carbon consumption can thus be obtained.

The test has lately been applied to ascertain the effect of coke size on the form and temperature of the combustion zone and has shown very clearly that the larger coke gives a relatively deeper combustion zone at a lower temperature; the smaller coke gives a higher temperature and steadier conditions of burning.

Combustibility Test in Practice.

As it appeared probable that this test was capable of grading cokes in order of their practical value, it immediately became very important to find a method of ascertaining whether the information it gave was correct in practice and on a large scale. Through the kind offices of Mr. Fletcher, who represents the British Cast Iron Research Association on the Committee, it was learned that, in the immediate neighbourhood, there were cupolas which would serve the Committee's purpose better perhaps than any others in the country for large-scale tests of cokes. These large cupolas, 5 ft. dia. by 17 ft. high to the charge door, melt 100-200 tons of iron in an eight-hour day and are fed and tapped continuously. Their melting ratio with a good coke is as high as 14 to 1, and they present conditions of steady flow ideal for the purpose of an accurate test. They require 25 to 30 tons of coke for a 3-day test, melting 300 to 360 tons of iron.

Evidently any such tests are dependent on the loyal and active co-operation of coke manufacturers. It is necessary sometimes to get cokes specially made under conditions which require the co-operation of rival coke-makers, and it is greatly to the credit of the industry in this area that such co-operation has been freely and fully given. It is right, too, to acknowledge how much the success of the tests is due to the active and continuous help given by Mr. R. O. Patterson and his staff.

Determination of Coke: Iron Ratio.

Essentially the test consists in finding by trial the coke: iron ratio required to attain standard conditions of melting. These are defined by taking account of blast pressure, blast volume, atmospheric conditions (pressure and humidity), metal temperature, weight of metal tapped, weight of iron and coke charged, and top gas temperature and analysis, all of which are observed at frequent intervals throughout the test. It is thus possible to secure, ultimately, substantially identical conditions in each test, and thus to compare the weights of coke required to produce them.

The blast pressure is fixed at the fan, and the blast volume is therefore determined by the resistance of the charge. Output is dependent on the quantity of air burnt; therefore the resistance of the charge determines output. The pressure drop through the tuyeres is considerable but fairly constant, say from 16 to 18 ozs. in the belt to about 6 ozs. in the furnace bottom. Ultimately the air-flow through the charge and therefore the output of the furnace depends wholly on this 6-oz. pressure.

With a given coke progressive reductions of the coke charge below a certain point (the charge of iron remaining constant) give progressively lower blast volumes and metal temperatures, and ultimately the blast volume falls off very markedly, apparently because slag freezes up around the top of the melting zone and materially narrows the effective cross-section of the furnace. The metal temperature does not fall to a corresponding extent, but the throughput is seriously diminished; one is then working, in effect, with a smaller cupola.

Results.

It is, in practice, generally possible to settle quite definitely within 2 or 3 per cent. the weight of coke per ton of iron required to give the standard optimum working conditions; *i.e.*, a metal temperature of 1,350 deg. C. at the spout and a throughput of about 110 tons per day. A series of slides giving the full data illustrate the nature and results of the tests. The first series of tests dealt with three ungraded cokes used in normal practice their consumption per 2,000 lbs. of iron were 160 lbs., 150 lbs. and 140 lbs. respectively. Their shatter indices, it may be remarked, do not accord with this order, but the order of merit assessed by the Combustibility Test is precisely that of the practical trials. A second series of three tests were made with the same coke, a beehive of excellent quality, in three grades; Coke No. 33, 66 per cent. over 3 in.; 32 per cent. over 4 in.; Coke No. 28, 95 per cent. between 1½ and 3 in.; and Coke No. 31, 95 per cent. between 1 and 2 in. The smallest grade was definitely too small in the 5-ft. cupola (though it would probably work well with a higher blast pressure), but the 1½ to 3 in. grade was very good indeed and gave as good a consumption and output as the large, run-of-oven coke, seemed to give steadier working and, as indicated by the gas analyses, was probably more efficient than the large coke.

A third test of great interest compared in two 3-day runs, two cokes made from identically the same coal in beehive ovens and patent ovens. These cokes, despite the wide difference in the mode of their carbonisation, were identical on the laboratory tests—in ash content, shatter index, porosity, and in the combustibility test. In the cupola they were found also to be exactly similar, giving the same low coke ratio of 140 lbs. per 2,000 lbs. of iron and the same output per day. This result encourages the hope that in the combustibility test there is at last a real means of assessing the practical value of cokes to the furnace or cupola manager, and there will probably be general agreement with the view that, should this prove on further investigation to be indeed the case, this issue alone would amply justify the whole effort of the Northern Coke Research Committee.

Conclusions.

The provisional conclusions to be drawn from the cupola tests may be summarised as follows:—(1) The shatter index does not correspond exactly (though it does so in a broad way) with the relative practical merits of cokes; (2) the combustibility test appears to place cokes in the same order of merit as the practical tests; (3) a smaller coke, down to 2 to 3 in., in a 5-ft. dia. cupola (and probably to a smaller size in smaller cupolas) gives as economical a consumption as a larger coke and is probably preferable from the point of view of consistent working, and (4) if made from a good coking coal, patent oven coke may be indistinguishable from the corresponding beehive coke either in laboratory tests or in its economy in practice.

Last week 3,029 tons of pig-iron and 890 tons of steel rails were shipped from the Prince of Wales dock, Workington, to foreign ports. The imports of foreign iron ore at the Prince of Wales dock for the quarter ending March 31, 1929, amounted to 35,300 tons, against 30,850 tons for the previous three months and 37,000 tons in the corresponding period of last year.

The Relationship between the Compression and the Transverse Strength of Cast Iron.

Sixty-two cast irons containing up to 6 per cent. of manganese have been tested by St. Nadasan,* and the relationship of the transverse strength to the compression strength calculated. The author found that this ratio increases with the increasing transverse strength. This can be explained by the influence of the graphite upon the mechanical properties of cast iron. The transverse test bar is broken when the tensile strength of the lower half of the bar is exceeded; the tensile strength of cast iron, however, is greatly influenced by the size and the distribution of the graphite, which interrupts the cohesion of the ground-mass. These interspaces of the ground-mass, however, are less important when the test sample is exposed to pressure. The formula the author calculated from the test data is:—

$$\frac{\text{Transverse strength}}{\text{Compression strength}} = 0.0935 \times \text{Transverse str.} + 0.75 \text{ kg./mm}^2.$$

This formula gives an average compression strength of 84.92 kg./mm.² for the samples investigated compared with 84.8 kg./mm.² found by actual testing; therefore the difference is +0.14 per cent. With 36 test samples (*i.e.* 58 per cent.) the difference between the calculated and the measured compression strength lay within the range of ±6 kg./mm.²; the greatest difference was ±20 kg./mm.² (found with four samples). Another series of experiments (46 samples) gave about the same results. An influence of the manganese upon the mechanical properties could not be stated.

Scottish Iron Works to Close Down.

The almost hopeless state of the Scottish pig-iron industry was discussed at the annual meeting of Messrs. Merry & Cuninghame, Limited, when it was announced that, subject to some development in the nature of Safeguarding, the directors had definitely decided to scrap their ironworks.

The company's balance-sheet showed that £41,148 had been added during the year to the outstanding loss, which is now carried forward at £226,339. During the year the whole of the company's blast furnaces were at a standstill.

Mr. Shaw Dunn, Chairman, said that in spite of reduced valuations on property and possible assistance under the De-rating Bill, the directors were not able to make iron at a profit.

A balance-sheet had been prepared showing that it cost 77s. to make a ton of pig-iron at the Ardeer works. Reductions in railway rates under the De-rating scheme would amount to 1s. 3d. per ton, making the cost of pig-iron 75s. 9d. per ton. The best price that could be received for it was 71s. 9d. The directors had come to the conclusion that the manufacture of pig-iron in Scotland on a remunerative basis was no longer possible. Unless some new discovery was made which would enable iron to be made at very much cheaper cost there seemed to be no future for the trade.

It might be that in the national interests the next Government might seriously consider the question of Safeguarding, and by that means keep the trade alive. Subject to some development of that nature, the directors had definitely decided to scrap their ironworks.

A fire which recently occurred at the Ormesby Ironworks, Cargo Fleet, of Messrs. Cochrane & Company, Limited, was confined to the pattern store in No. 7 foundry, which, however, was destroyed, some valuable patterns being lost.

* "Die Giesserei," 1928, No. 50, pp. 1251/3.

An American Hot-Blast Cupola Plant.

Whilst but little success rewarded the efforts of those pioneers who launched the hot-blast cupola into Britain, it seems that real progress is being made in America. The large plant at the Griffin Wheel Company has been in successful operation for some years, and now Mr. Rogers A. Fiske, writing in a recent edition of "The Iron Age," details the results which have been obtained in a second installation recently laid down in the works of the Pullman Car and Manufacturing Corporation, Michigan City, Indiana. The results, whilst not very striking from a British point of view, do indicate matters of interest to our readers, and we have abstracted below its principal features.

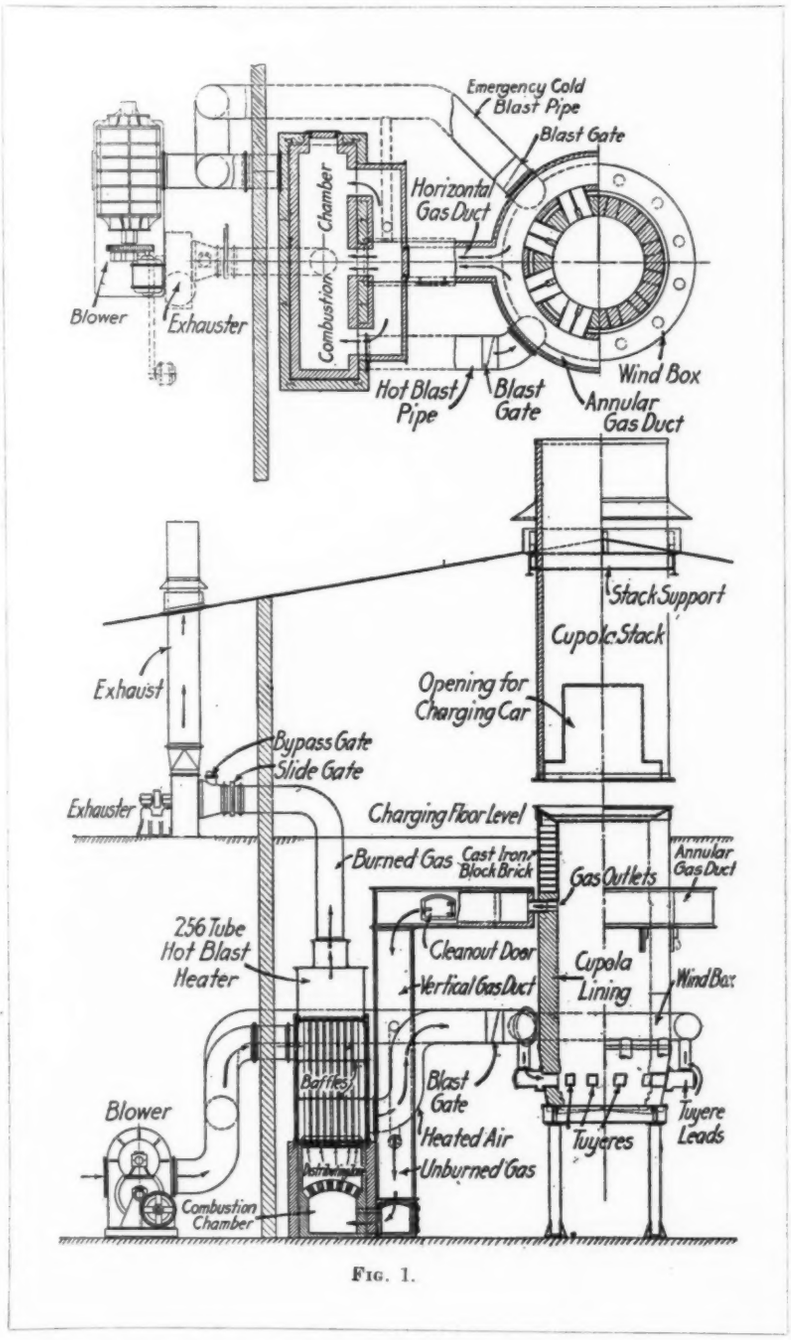


Fig. 1.

The replacement of two cold-blast cupolas by a single hot-blast unit in this case resulted in substantial savings in coke, power, and man-hours of labour. Other features of the new installation are:—(1) It is seldom necessary to chip out hanging metal before patching; (2) bridging over the tuyeres occurs only at rare intervals; (3) lining at the melting zone burns out uniformly and never to the extent where a new block brick is required to build out the lining; (4) low blast pressure and the withdrawal of gas eliminates flames at the charging door, thus facilitating proper levelling of the charge; (5) test pieces are uniform throughout the day with resultant uniformity in casting shrinkage; and (6) once the metal is brought up to temperature, its heat can be held with a blast pressure as low as 1 oz.

When operating one of the old units, the yard and cupola forces comprised 17 men, and when both old cupolas were in blast 28 men were needed. Each old unit had an average capacity of 135 tons in an 8-hr. melting period. The hot-blast cupola, which has been provided with improved material-handling and charging equipment, requires 12 men for an output of 250 tons in an 8-hr. melting time and its full capacity, it is asserted, has not been reached. The old cupolas were designed with 96-in. shells, which had been lined down to 66 in.

New Methods of Charging Used.

With the installation of the new equipment a chain-type conveyor was placed beneath the old wheel-breaker, which has been moved to a more central situation. Broken wheels fall from the breaker to the conveyor for delivery, without rehandling, to an iron-charge bogie which stands on a track scale. An air-operated kicking device moves the weighed bogie forward so that one man exerting a slight additional push can place it on the skip hoist platform. The skip hoist discharges its load directly into the cupola.

Coke is now loaded in bogies direct from railway cars. If a coke-car is not emptied by the end of the day's run, it is unloaded on the ground, thus saving demurrage on the car. This coke is the first to be used the next day. The coke bogie, when loaded and weighed, is wheeled to the skip hoist platform. It also is dumped automatically into the cupola. Twelve men in the yard and at the hot-blast cupola suffice.

The new cupola was designed with a 120-in. shell, which has been lined to 84 in. Should it become desirable, the lining may be removed to give an inside diameter of 96 in. It is interesting to note that according to estimates made previous to the installation it was thought that, with the foundry operating at capacity and requiring 250 tons of metal a day, the 96-in. melting zone would be required. In practice, however, that capacity has easily been obtained with the 84-in. diameter zone.

This unit is operated as a continuous tap cupola, whereas the old units were tapped intermittently, as in ordinary foundry practice. A bull-ladle is filled by a spout 9 ft. long leading from the cupola. This spout is designed with the usual built-in puddle, which serves to skim slag from the iron. The pouring ladles are of 2 tons capacity, this being the amount of metal needed for pouring two carwheels. The pouring ladles are brought into position in front of the bull-ladle on cable-operated cars which run on an industrial track. By this means they are moved opposite the pouring bays, which are equipped with overhead trolley systems. The cars and the bull-ladle are operated by one man stationed near the cupola.

Twelve 10-in. by 10-in. tuyeres open from the wind box into the cupola. These are arranged and designed as in standard cold-blast practice. The centres of the tuyeres are 23 in. above the base plate and 23 ft. 6 in. below the gas outlet tuyeres. An annular gas duct is attached to the shell 7 ft. 2 in. below the charging door sill. Gas ports, 6 in. by 6 in., open into it from the cupola. This duct is of welded steel plate construction and is lined with 4 in. of firebrick. Similarly, the gas duct that leads to the combustion chamber of the heater is made of welded steel plates, lined 4 in. on the inside; on the outside is an asbestos covering to protect workmen who might come in contact with it.

The temperature of the gas leaving the cupola is about 760 deg. C. The gas duct connects with a header which has three openings into one side of the combustion chamber. This chamber is 3 ft. 9 in. wide by 17 ft. 6 in. long by 3 ft. 6 in. high from the floor to the sprung checkerwork arch. Heated air for combustion is admitted to the combustion chamber at the gas ports. Average analysis of the gas leaving the cupola is CO_2, 15 per cent., CO, 8.4 per cent., and N, 76.6 per cent. by volume.

Special attention has been given to the design of the arch that separates the combustion chamber from the distributing zone. Ports in the arch are arranged to give even distribution

of the gas to the heat transfer pipes. The side thrusts of the arch are taken by heavy beam sections that extend along the outside of the combustion chamber. The distributing zone has about the same cubic contents as contained in the combustion chamber. The walls of these two chambers, constructed of 12 in. of brick, form the support for the heater section.

The lower tube sheet, which is insulated on the high-temperature side, is made of cast iron. The tubes, which are also cast iron, are spaced on 6-in. centres and fit into tapered holes in the tube sheet. There are 256 tubes, each 9 ft. 4 in. long and 4 in. outside diameter, providing about 2,250 sq. ft. of heating surface. The hot gas from the distributing zone passes vertically through the tubes to a gas-collecting chamber which is mounted above the upper tube sheet. The shell of the heater is made of welded steel plate. The upper tube sheet is similar to the lower one except that it is not insulated. Brick walls completely enclose the heater.

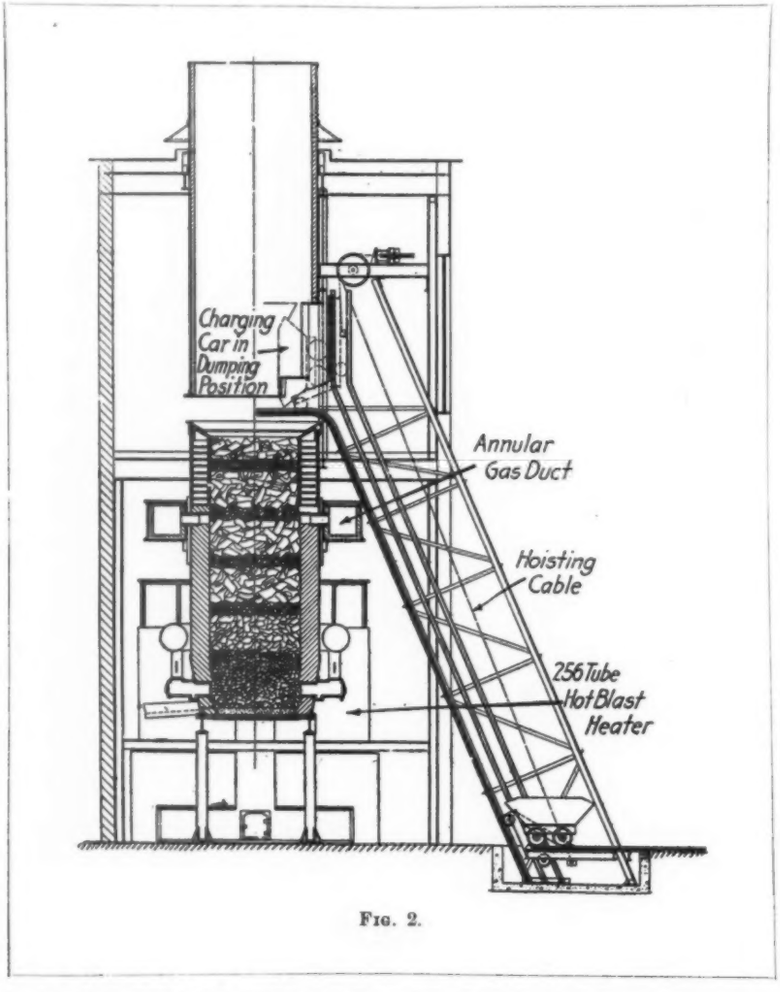


Fig. 2.

Within the heater are two horizontal steel baffle plates. Air from the blower enters at the top near one end of the heater and makes three passes across the tubes as it travels down to the outlet, which is at the opposite end of heater.

The temperature of the gas in the combustion chamber ranges up to 927 deg. C. The temperature above the arch is 845 deg. C. As the gas travels up through the tubes its temperature drops to about 315 deg. C. Air enters the heater at room temperature, or an average of 21 deg. C., and it is discharged to the cupola at 232 to 260 deg. C., which is a rise of 190 to 218 deg. The drop in air temperature between the heater and the cupola is negligible for the reason that the run is very short.

Waste gas is drawn from the top of the heater through a flared header to which is connected a duct leading to a single-end exhaust fan, driven by a 10-h.p. motor. The suction maintained on the gas line at the cupola is ¾ oz. This induced draught fan is located on the charging floor, where it is readily accessible to the operator.

The blast fan is driven by a 75-h.p. motor and it normally takes 35 h.p. Air-pressure at the cupola is 7 ozs. to 9 ozs. This contrasts with 12 ozs. to 14 ozs. required at the cold-blast cupolas. This difference in air pressure, as well as volume of air required because of the smaller amount of coke used, accounts for a large saving in power charges.

About 40 per cent. of the cupola gas is drawn to the combustion chamber. The remainder passes through the upper iron line at about 65 deg. C.

The tabulated results are typical of the operation of this hot-blast cupola. The figures given are not representative of operation at or near maximum output, for when the data were gathered the foundry was producing at only 50 per cent. of its rated capacity. Since these figures were obtained a melt of 35 tons per hour, or 245 tons in 7 hrs., has been obtained.

An 8-in. bypass and gate are provided so that the cupola can be operated with a cold blast if required. The change from hot- to cold-blast means increasing the blast pressure from 7 ozs. or 9 ozs. to 12 ozs. or 14 ozs. A 10-in. bypass and gate provide a means of drawing gas from the duct, ahead of the heater, direct to the exhaust fan. This arrangement is effectively used to control the temperature of the gas reaching the fan. The maximum temperature allowable at that point is 399 deg. C. Bypassing a part of the gas reduces the rate of combustion in the heater and thereby lowers the temperature of the exhaust gas.

Blast pressure at the cupola, blast temperature at the cupola and gas temperatures at the exhaust fan, over the arch and at the cupola, are indicated on a control board.

Clean-out doors are provided in the side walls of the combustion chamber and the distributing zone and manholes are located in the chamber above the heater. About once every two weeks dust and soot are removed from the heater. No trouble has been experienced from fusion of dust particles in the combustion chamber or in the arch ports. The gas mains are cleaned once a week.

The hot-blast cupola and auxiliary equipment were designed and installed by the Griffin Engineering Company, Chicago. The material-handling equipment was manufactured by the Link-Belt Company, Chicago.

Table I.—*Operating Details of the Hot Blast Cupola.*

Temperature of gas in combustion chamber, deg. C.		927
Temperature of gas leaving cupola, deg. C.		760
Temperature of gas above arch, deg. C.		845
Temperature waste gas above heater, deg. C.		326
Temperature of gas at charging door, deg. C.		65
Blast pressure, oz.		8
Suction, oz.		¾
Tons melted per day		172
Rate of melting, tons per hr.		32.21
First iron at		8.30 a.m.
Bottom dropped at		1.50 p.m.
Coke consumed per min., lb.		80
Coke consumed per min. per sq. ft. of area of combustion zone, lb.		2
Iron melted per min. per sq. ft. of area of combustion zone, lb.		26
Bed Coke:		
Supporting coke, lb.	5,100	
First charge, lb.	1,025	
Total bed coke, lb.	6,125	
Coke Required per Ton of Iron:		
Bed, lb.	30	
For melting (including extra), lb.	154	
Total, lb.	184	
Melting ratio: 1 to 13.		
In-Puts:		
Iron charge, lb.		13,500
Coke charge, lb. (carbon)	892	
(Ash moisture, etc.)	133	
		1,025
Oxygen, lb.		2,185
Nitrogen, lb.		8,740
Total, lb.		25,450
Out-Put:		
Iron, lb.	13,500	
Less oxidation, 2 per cent.	270	
		13,230
CO_2 (15 per cent.), lb.		2,453
CO (8.4 per cent.), lb.		519
N (76.6 per cent.), lb.		8,740
Fe_2O_3, MnO, $Si O_2$, lb.		375
Ash, moisture, etc., from the coke, lb.		133
Total, lb.		25,450
Heat Balance, One Lb. Coke (B.t.u.):		
Heat developer in combustion		9,900
In hot blast at 260 deg. C.		900
Total heat developed		10,800
Heat Used:		
In recuperator		1,500
Radiation		575
Slag formation		750
Breaking up limestone, dissociating moisture, etc.		775
Gases leaving recuperator		500
Gases leaving cupola at charging door		200
Melting 13 lb. iron		6,500
Total used		10,800

Progress of Electric Furnaces.*

By W. S. Gifford.

The use of electricity in metallurgy has gone through several stages. The earliest developments took place in countries where cheap water power was available, such as France, Scandinavia, and parts of the United States, and consisted chiefly in the production of aluminium, ferro-chrome, and ferro-silicon, though some progress was made in the electric smelting of iron ore and the melting of steel in arc and induction furnaces. Up to the beginning of the war progress in electric steel melting was slow. There were about five furnaces in England, and several scattered about the Continent, while some progress had also been made in the United States. Probably many remember the grand tour of Europe which was regularly made in the years between 1910 and 1913 by any steelworks metallurgists who could persuade their directors that electric steel melting was worth investigating. It consisted of a visit to Savoie to see a Héroult and Girod furnace; from there to Turin to see Stassano's works; thence to see a Röchling Rodenhauser furnace at Völklingen, and on the part of those who had soft-hearted directors or an elastic conscience a detour home by way of Schaffhausen and Remscheid to see two more Héroults. As one who was at the time deeply interested, the author can only say that the ratio of the number of furnaces ordered to the mileage covered was disappointingly low.

The war made a great change in electro-metallurgy. The immense demand for alloy steels for motor transport, tanks, aircraft, bullet-proof shields, helmets, and other purposes, caused a great demand for electric furnaces, and by the end of 1918 there were over 80 electric steel-melting furnaces at work in Great Britain capable of producing about 200,000 tons per annum. At the end of the war it was difficult to find any use for a large proportion of these furnaces, and many were shut down and finally dismantled or sold for use in other countries.

The Re-Introduction of the Induction Furnace.

For nearly nine years there was very little development in steel furnace electro-metallurgy, though a great deal of progress was made in non-ferrous melting, where the Ajax-Wyatt induction furnace, which was developed in America towards the end of the war, was adopted to a large extent for melting brass in Birmingham and elsewhere. A few new arc furnaces were installed in steelworks, but these were considerably fewer in number than those shut down. A number of small furnaces were also installed for heating tool steel electrically, and several laboratory high-frequency furnaces of the Ajax-Northrup type were erected in laboratories for research purposes, though the principal installations were made for making nickel iron carbon free alloys.

Recent Progress.

In the last two years, however, fresh progress has been made in two directions. Electricity is being more and more widely used for heat treatment, for which purposes resistance furnaces are used, while the development of the Ajax-Northrup, and later of the Metropolitan-Vickers high-frequency furnace, has at last seriously menaced the ancient supremacy of the crucible process, which has often before been threatened but has always risen triumphant over its enemies.

Arc Furnaces.

The earliest type of electric furnace to be widely developed, and that which is probably best known, is the arc furnace, of which the best known types in this country are the Héroult, Greaves-Etchells, and Electrometals. In the early days, when patents were still in force, there was a great deal of argument about the advantages and disadvantages of bottom electrodes, but since all the older fundamental patents have lapsed most manufacturers have come back to the simpler type, in which there are three overhead electrodes and no bottom connection. The latter is frequently a cause of trouble, and while a really skilful furnace man can get excellent results, it is certainly considerably more difficult to operate successfully.

The modern furnace is essentially not very different from that of the 1914 model, the principal difference being that in these days more power is usually used and the voltage is higher. This is certainly an advantage in the case of a foundry, though when tool steel is being made it is rather doubtful, as time is an essential factor in the process of manufacture. The other variations in the present design from the older models are principally refinements such as water-cooling the doors, automatic hydraulic regulation, swivelling electrodes and arms, etc., though the former was used on some Héroult furnaces over fifteen years ago. Some of these refinements are of doubtful advantage, as the essence of a good arc furnace is simplicity.

Soderberg Electrodes.

What is really in the author's opinion much the biggest advance in the arc furnace has unfortunately been entirely neglected in this country. The Soderberg continuous electrode has been in use in steel furnaces on the Continent for about eight years, and there are now about 40 steel furnaces using this process, varying in size from 2½ to 20 tons. The chief advantage of the Soderberg electrode is that it uses the waste heat of the electric furnace to bake the electrode. A paste made of the ordinary electrode material —calcined anthracite, coke and tar and pitch— is inserted into a ribbed cylinder of about 18 to 20 gauge steel sheet. The top part of the electrode thus consists of unbaked material and the lower end is continually baked by the furnace.

A water-cooled electrode-holder is used, which is usually rather deeper than the ordinary holder, owing to the softness of the material at the point of contact. The electrode is lowered by loosening the holder in the ordinary way, and the current can be kept on during the process. In a ferro-alloy or carbide furnace the process is usually a continuous one, a platform being installed above the furnace for jointing the sheet cylinders and tamping in the paste, but with a steel furnace it is usual to do this work away from the furnace.

Furnaces requiring electrodes varying from 10 to 90 in. in diameter are using this principle, which greatly reduces the cost of electrodes—a rather heavy item in arc furnace work. Figures published of the results obtained in Continental steelworks show a saving of about half the cost of electrodes.

On the Continent and in the United States the arc furnace is being used to a considerable extent in the manufacture of cast iron. The furnaces are being employed either to refine and superheat metal from the cupola, where a considerable improvement in quality is claimed, or to melt steel scrap. Héroult furnaces are being employed in Switzerland in this way for the manufacture of Diesel engine cylinders, and no difficulty* is now found in bringing the carbon up to 3.5 per cent. It is stated, however, that, owing to the greater softness and machinability of the metal, a carbon content as low as 2.8 per cent. gives satisfactory results. The author knows of one plant only in this country in which arc furnaces are being used for making iron castings, but we think that the matter is well worth the consideration of foundrymen.

Induction Furnaces.

The next class of furnace to be considered is the normal frequency induction furnace. A few of these were installed in Sheffield between 1907 and 1910, but for various reasons they were all abandoned. Wyatt, in about 1916, conceived the idea of using a vertical instead of a horizontal slot, and the furnace constructed on this principle was an immense success in the melting of brass wherever it was possible to work a furnace more or less continuously on one class of metal. There are now over 650 of these furnaces at work throughout the world, of which about 55 are installed in this country. The total output is over 1,000,000 tons a year.

This furnace is now also being used for melting nickel-silver, but it is not suitable for steel making, as so far no refractory has been found which will withstand the combination of high temperature and physical strength required for this purpose, while it possesses the inherent disadvantage of this class of induction furnace of requiring part of the charge to be left at the end of each heat in order to form the transformer secondary circuit to start the next heat. This makes it necessary to keep the furnace working as nearly continuously as possible, while it is unsuitable for making consecutive heats of a wide variety of metals. Experiments of a promising nature are, however, being carried out in Ajax-Wyatt furnaces in connection with iron, and it appears probable that induction furnaces may be usefully employed as mixers and superheaters for iron for malleable castings, and high-grade cast iron for cylinders, etc.

High-Frequency Furnaces.

The most interesting improvement in furnace practice which has been made for a long time is the development of the ironless induction furnace. This process, which, at any rate in the melting of steel, is dependent on the use of high-frequency current, gets over the difficulties inherent in the older type of induction furnace. In principle it is very simple. High-frequency current—so far single-phase—is obtained from a motor generator running at from 1,500 to 3,000 r.p.m., the periodicity varying from about 500 to 2,200 in accordance with the size of the furnace and other considerations, such as the most economical generator speed and the cost of condensers, the number of which varies inversely as the frequency. This current is brought to a water-cooled coil surrounding the crucible or formed lining, and the metal is heated by eddy currents.

Theoretically, this is the ideal method of melting. The heat is produced where it is wanted—in the metal itself, so that a very high efficiency is obtained. There is a complete absence of furnace gases, and a powerful circulation due to electrical effects, which ensures a complete mixing of the charge, and is especially useful in the case of high-speed and similar steels. The high efficiency of the furnace is to a certain extent offset by the fact that a motor generator is essential to the process, the efficiency of which is from 75 to about 85 per cent., depending on its size, etc., so that the total power consumption is about the same as that of an arc furnace. Although the power factor of the furnace is low —from 0.15 to 0.2—it is brought approximately to unity by the insertion of condensers, and consequently the load is very attractive to power companies, as the load factor and power factor are high and variations of current negligible.

Refractory Linings.

As a lining for the furnace, either clay or graphite crucibles may be used, the former having an average life, when melting steel, of 12 heats, and the latter of 20 heats. The cost of the former is about 36s. each, and of the latter

* A Paper read before the Sheffield Branch of the Institute of Metals. The Author is a Director of the Electric Furnace Company.

* Steelworks metallurgists have long failed to realise that ironfounders do not want high total carbon.—Editor.

67s. 6d. A more recent development is the formation of a lining in the furnace by a rather ingenious method. A steel liner of the size of the crucible is inserted in the furnace, a special siliceous powder is placed round and beneath it, and the current turned on. The liner is heated by induction, and before it is melted the powder is sufficiently fritted to form a sound lining. Experiments are now being made with magnesite linings made in the same way, which will enable a basic process to be carried out. By this method the life of a lining has been increased to an average of about 60 heats, and the cost in a 5-cwt. furnace has been reduced from 35s. to a few shillings per ton.

This method of heating is being used in the steel trade, principally for the production of high-speed and other tool steels and for the remelting of stainless iron and steel (where the fact that there is no increase of carbon and practically no loss of chromium is a great advantage), and for heat-resisting steels.

A Steel Foundry Installation.

A more recent use of this type of furnace in ferrous metallurgy is the installation of an Ajax-Northrup furnace in a steel foundry. This furnace was primarily installed for the making of small cast letters of cobalt steel, which are subsequently magnetised and used for signs in theatres, restaurants, etc., where it is constantly necessary to change the names of the caste or the bill of fare. The furnace is also being used for making other light castings, and the results have been so satisfactory that a furnace of twice the size is now being installed. It is intended with the new installation to arrange a conveyor on which the moulds will be placed, which will be brought in front of the furnace, so that the metal will be poured direct into them, thus avoiding the use of a ladle or handshanks. This will not only greatly reduce the cost of labour necessary for casting, but will also enable the steel to be poured at a lower temperature, as the loss of heat in transferring to the ladle will be avoided.

Melting Speeds.

One of the great advantages of high-frequency melting, especially in a foundry, is the high speed of melting. A heat is made once an hour, so that a 1-ton furnace is about equivalent in output to a 4-ton arc furnace or an 8-ton open-hearth furnace. When allowance is made for the greatly reduced floor space required and the much lighter building and cranes necessary, it will be realised that the capital cost in a new shop may be considerably less in the case of a high-frequency installation than that of other types.

So far the steel furnaces at work in this country have all been of 150-kw. motor generator capacity and holding from 4 to 5 cwts. In the steel trade Great Britain was the first to realise the possibilities of this method of heating, and two installations were at work before any steel furnaces were installed elsewhere. Lately, however, progress has been more rapid in France than here. In England there are now seven Ajax-Northrup or Metropolitan-Vickers furnaces in operation or construction in the steel trade, of a total capacity of 1,050 kw., while five, of a total capacity of 750 kw., are working or being installed in non-ferrous works. In France seven steel furnaces and one non-ferrous furnace, of a total capacity of 2,150 kw., are working or being constructed. The largest furnace making steel here is of 4 to 5 cwts. capacity, but for France one 1-ton furnace and two 12-cwt. furnaces are being built, while an installation of four 1-ton furnaces is expected to be made shortly. The French furnaces have been designed in England, and most of the equipment is being manufactured here, but it seems a pity that a new process, the advantages of which were first recognised here, should be more widely used in another country.

The question of the best periodicity to use is one that has been very carefully examined. About four years ago the Electric Furnace Company made a series of experiments in full-sized commercial furnaces, to determine the frequency and voltage which was most satisfactory for both ferrous and non-ferrous work for different-sized furnaces. The furnaces tested were of frequencies of 500 and 2,000. This investigation covered both electrical design and the more important question of metallurgical efficiency, both as regards metal melting and maintenance of refractories.

It was found that, with too low a periodicity, the movement of the metal was too violent, both from the point of view of maintaining a slag covering and of the life of the refractory. The firm has, accordingly, standardised on a frequency of not lower than 1,000 for all steel furnaces up to one ton capacity at least. A comparatively high frequency also reduces the cost of condensers, which varies almost inversely as the frequency. The cost and efficiency of the generator is practically the same as for lower frequencies.

Electric Resistance Furnaces.

The use of electric resistance furnaces for heat-treatment has considerably increased in recent years, and, as the price of electricity falls, there is every probability that the amount of power used for this purpose will greatly exceed that used for melting, as it has in the United States.

To-day, there are probably about 46,000 kw. used for melting in Great Britain, of which 40,000 kw. are employed in ferrous and 6,000 in non-ferrous metallurgy, while the heat-treatment figures are of the order of 7,000 to 10,000 kw., though these figures are impossible to determine accurately, as no data are published, some works having installed their own plants. This, by the way, is a somewhat perilous thing to do. It looks extremely easy to convert an existing furnace, so as to heat it electrically. All one has to do is to string up a few wires, and the job is done. In practice, however, there is much more in it than that. An electric-resistance furnace requires as careful designing as any other type of electric furnace, if it is to be efficient. Electricity in England is a relatively expensive source of heat, and for a furnace to be economical heat losses must be carefully studied. On the other hand, with an intermittent process, the furnace must not be too slow to reach the required temperature, which may be the case if the insulation is too heavy.

Broadly speaking, electricity is the best method of heating where extreme accuracy of temperature control and an absence of all impurities inseparable from other forms of heating are sufficiently important to counterbalance some extra cost, or where there is a long soaking process in which the furnace has to be maintained at a constant temperature for long periods, where electric heating is frequently cheaper.

In a resistance furnace the temperature of the heating element may be only a few degrees above the temperature of the furnace chambers, while in a fuel-fired furnace this is not the case. In consequence, when a furnace has to be held at a fixed temperature, the only loss in an electric furnace is that due to radiation, which in a well-designed plant is very small, whilst in other types of furnace there is a constant loss of heat in the gas.

The spring-manufacturing shops at the High Yard Works of Messrs. J. Spencer & Sons, Newburn-on-Tyne, together with the plant and equipment, have been sold by Messrs. Thos. W. Ward, Limited, Sheffield, who are dismantling the works, to a firm who are to re-commence the manufacture of springs for home and foreign railways and shipping companies. Hopes are entertained that the remaining portion of the site will attract some new industry and find employment for the large number of men who are still out of work through the closing of the High Yard Works.

Utilisation of Coke Breeze for Steam Boilers.

The Value of Blending with Coal.

(By Our Engineering Correspondent.)

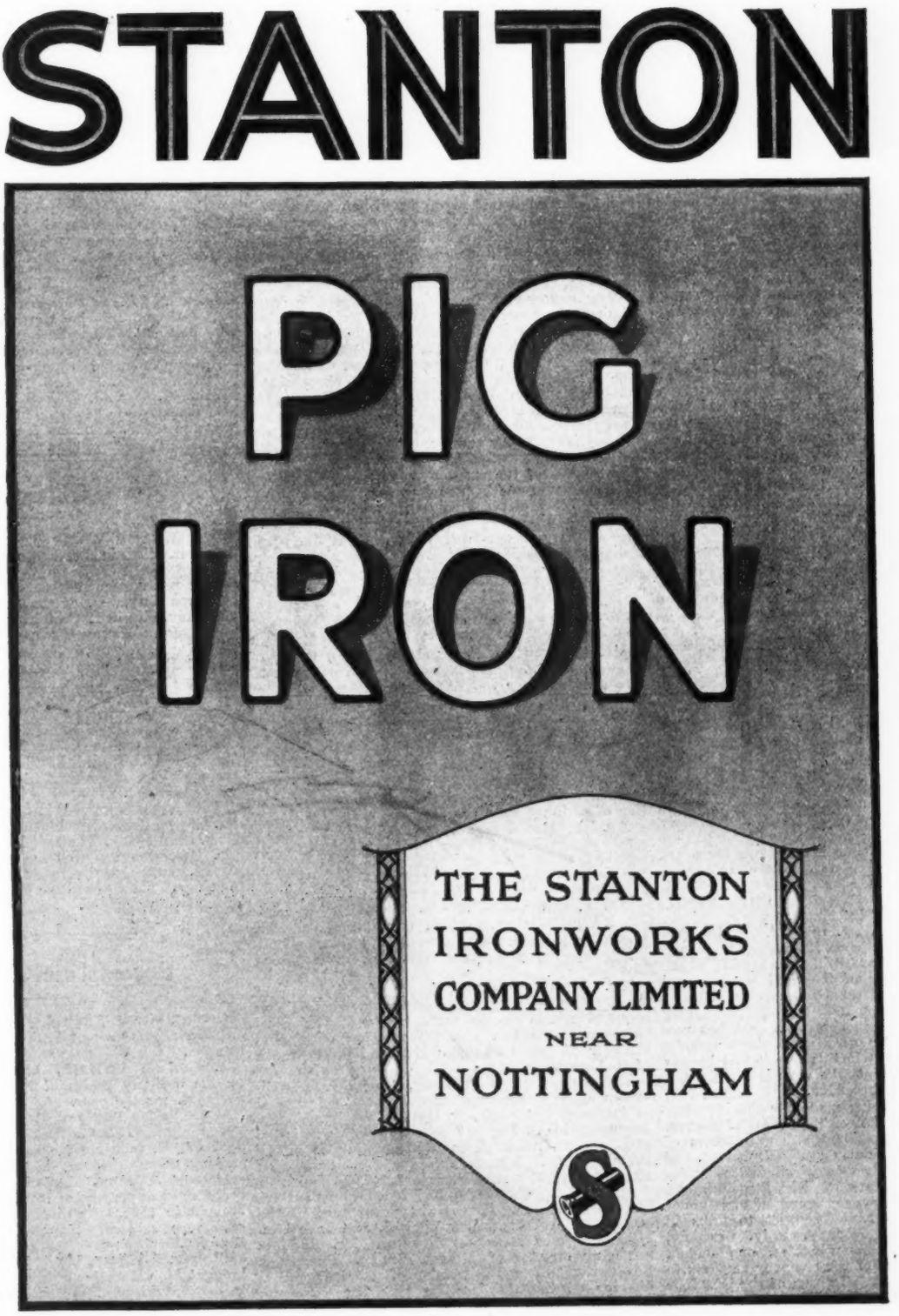
An interesting indication of the more scientific methods now being adopted for boiler plant operation is the blending of the coal or other solid fuel, both as regards preventing black smoke and reducing the fuel bill. The subject is of considerable importance, because, for example, all the foundry coke dust and breeze can be utilised on these lines, and the method is also applicable to boiler plants of every kind, from the smallest industrial installation to the largest power station. The value of the principle is well illustrated by an interesting series of trials carried out just recently at the works of a well-known Lancashire firm of tar distillers, using mixtures of coal at 17s. per ton, and in this case gasworks coke breeze at 8s. per ton, available under the particular circumstances. Essentially the plant consists of three 30 ft. × 8 ft. internally-fired cylindrical "Lancashire" boilers, feed water economisers, and superheaters, with hand-fired "Turbine" forced-draught furnaces, and the coal was 13,177 B.Th.U. per lb., with 5 per cent. ash and 21.9 per cent. moisture, being an exceptionally good quality, while the corresponding figures for the coke breeze were 10,890 B.Th.U. per lb., 15 per cent. ash and 9 per cent. moisture.

The net result was a substantial economy in net cost of production of steam when using a blend of 1:2 coal and breeze, or 1:3, as against 2:1 coal and coke breeze, or coal only. Thus, for example, the cost of evaporation of 10,000 lbs. of steam per hour with two parts coal and one part breeze, was 7s. 10d., whereas the figures for 1:2 coal and breeze was 6s., and 1:3 coal and breeze 5s. 9d. In all cases the performance represented average industrial practice, 685-756 lbs. of fuel burnt per hour, with an evaporation of 4,500-5,050 lbs. of water per hour in continuous daily running, the economisers, however, being of small size, with 85-95 lbs. of steam pressure and 470 deg. Fah. superheated steam temperature. The net thermal efficiency also is about 68 per cent., and under these circumstances the figures of one part coal and two parts breeze is now used regularly, since increasing the breeze beyond this point makes little difference, but of course with very great saving as against the previous practice of coal only.

It is well known that a scientifically-designed forced-draught furnace of this description with uniform distribution of the air-blast, longitudinally and transversely, varied in amount as desired, will burn almost any solid fuel, including, without blending, if necessary, foundry-coke breeze and dust, as well as small slack and low grade coal, hand firing being retained as usual.

Finally it may be emphasised that blending of coal for combustion has long been neglected, although long practised, of course, in coke-oven work by mixing two or more coals to improve the quality of the coke.

Messrs. Alfred Herbert, Limited, Coventry, state that their licencees in Belgium, the Société Anonyme Ateliers J. Hanrez, Monceau-sur-Sambre, have received an order for two Atritors for the Fabrique Nationale d'Armes de Guerre, of Herstal. Recent contracts secured by the Riley Stoker Corporation, who manufacture the Atritor under licence for sale in the United States, include four machines, each of 10,000 lbs. per hr. capacity, for the Byllesby plant in Oklahoma; three machines, each of 10,000 lbs. capacity, for the Sunbury Converting Company, Sunbury, Pa.; and three machines, of the same capacity, for the Frasier Company, of Canada. In the case of the Byllesby contract, there are two boilers, each fired by two machines, and the equipment is designed for a normal load of 90,000 lbs. of steam per hr. per boiler, with a maximum capacity of 150,000 lbs.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

The metallurgical industry of Switzerland imported during 1928 pig-iron to the value of £720,000. In 1927 only about two-thirds of this amount was imported.

The employees of Messrs. Duncan, Stewart & Company, Limited, London Road Iron Works, Glasgow, have contributed £111 to Glasgow and West of Scotland charities.

Arrangements are being made to transfer the registered office of Messrs. Cammell Laird & Company, Limited, from Cyclops Works, Sheffield, to the offices of the company at their Birkenhead shipyard.

Over 120 members of the Ironmongers' Assistants' Association from London, Guildford and Southend visited Ipswich on April 18 as the guests of Messrs. Ransome, Sims & Jefferies, and inspected the various departments of the firm at Orwell Works.

Messrs. G. & J. Weir, Limited, Glasgow, have secured a contract to supply pumps to the Saskatchewan Government. Messrs. C. A. Parsons & Company, Limited, Newcastle-on-Tyne, are to supply a turbo-generator to the same Government and powerhouse machinery to the City of Regina.

Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, have contracted to build four high-class cargo steamers, each of 8,000 tons dead-weight, for London owners. Steam reciprocating machinery will be supplied by the builders. This is one of the biggest contracts booked by any single firm in Greenock for many years.

In view of his impending departure for London to take up his new duties as director of the Tunnell Portland Cement Company, Limited, and of Messrs. Smidth & Company, Limited, Mr. E. H. Lewis, general manager of the Glasgow Iron and Steel Company, Limited, was met at the works recently by the staff and workmen and presented with a gold wristlet watch, together with a silver, gilt and enamel toilet-set for Mrs. Lewis.

The directors of the Carron Company have specially prepared, and turned into a playground for the children of the district, a considerable area of land at West Carron. The opening ceremony and public presentation of the ground took place on April 20. Mr. George Pate, general manager, presided, and Mrs. F. L. Burder, wife of the chairman of the company, formally declared the ground open by severing a ribbon with a pair of silver scissors, which she was asked to accept as a memento of the occasion.

At a meeting of British Insulated Cables, Limited, held at Liverpool on April 16, resolutions were passed increasing the capital of the company by the creation of 333,333 £1 ordinary and 500,000 £1 "A" 5½ per cent. cumulative preference shares. The new shares will, pursuant to resolutions also passed at the meeting, be allotted (credited as fully paid up) *pro rata* among the ordinary shareholders in the proportion of one ordinary share for every four, and three "A" preference shares in respect of every eight ordinary shares held on April 24, 1929.

Recently Mr. J. M. Primrose, manager of the Grangemouth Iron Company, Limited, Falkirk, presented a handsome trophy in the form of a silver bowl for the best-kept garden in the Camelon Ward. It is to be the property of the local Horticultural Society for all time, and cannot be won outright by any competitor. Captain H. J. Kennard, managing director of the Falkirk Iron Company, has now signified his intention of providing a similar trophy for the North Ward, but in this case it will become the property of the tenant who wins it three times, but not necessarily in succession.

Arrangements are being made for the introduction to the London market of the shares of Messrs. Burmeister & Wain, the Danish manufacturers of Diesel motors. The business dates back to 1846, and in recent years it has been confined almost exclusively to the manufacture of Diesel motors and motor-ships. Licences to construct motors under the company's patents have been let to firms in Great Britain, Sweden, Norway, Italy, Germany, France, Austria, the Balkan States, and Japan. The issued share capital of the company amounts to Kr.30,000,000 (£1,652,000). In each of the past four years the company has paid dividends of 8 per cent. on an increasing capital, the earnings for 1928 being equal to 21.7 per cent.

Messrs. Bibby Brothers & Company, Liverpool, have placed with the Fairfield Shipbuilding and Engineering Company, Limited, Govan, Glasgow, an order for a fourth twin-screw motor-ship, similar in general design to, but somewhat larger than, the three which have already been built for them at the same yard. This vessel will be an improvement on the "Staffordshire," launched last October. She has been designed for trading between Great Britain, India and Burmah, and will be 483 ft. 6 in. in length and 62 ft. 6 in. in breadth, propelled by Fairfield-Sulzer internal-combustion engines, each set of which has eight working cylinders, 28 in. dia., with a stroke of 39 in., capable of developing an aggregate of 7,700 b.h.p. at 110 r.p.m. and giving a service speed of 15½ knots.

Much satisfaction is felt throughout the district of Low Moor, Bradford, by the news that the Low Moor Ironworks are to continue and a reconstruction is now taking place. Arrangements have been made by the present holders, W. Ward, Limited, Sheffield, with another company to work the forge and rolling mills so as to continue the manufacture of the famous Low Moor, Farnley, and other best Yorkshire wrought irons. Other interests have also taken over the blast furnaces, coke ovens and by-products plant, where the production of the well-known cold-blast pig-iron will be continued. A large number of workers were previously employed at the various works, and the good news that substantial sections of the old company are to be carried on will be welcomed in view of the uncertain prospects of future employment.

Meetings of the shareholders of Messrs. Darwins, Limited, steel manufacturers, of Sheffield, were held in Sheffield on Friday last to consider the proposed sale of the undertaking to a new company of the same name with a nominal capital of £730,000. The liquidator, in a circular to the shareholders, states that from June, 1927, to November, 1928, there was a net profit of £58,147. Under the proposed scheme all creditors will be paid in full, with interest, so that the new company will start entirely free from debt, except for a mortgage on the works. The holders of the cumulative participating preference shares in the company will receive one fully-paid "B" preference share in the new company for every preference share held. The holders of the ordinary shares will receive three fully-paid ordinary shares for every five ordinary shares held.

Personal.

Mr. S. Samuel, iron and steel merchant, of London, has been adopted as prospective Conservative candidate for the Lichfield division.

Mr. R. W. Matthews, managing director of Messrs. Turton Bros. & Matthews, Limited, crucible steel makers, of Sheffield, has been elected President of the Sheffield Chamber of Commerce.

Mr. Frank Brown, assistant chief docks manager of the Great Western Railway, has been recommended by Bristol Docks Committee for the position of acting general manager of the Bristol Docks.

Mr. Douglas Arthur, of the electrical department of the Falkirk Iron Company, Limited, has left to take up a position as Scottish representative for Messrs. Lane & Girvan, Limited, Caledonia Stove and Electrical Works, Bonnybridge, Glasgow.

Mr. F. Rowlinson, at present publicity manager for Messrs. Mather & Platt, Limited, Manchester, is shortly to take over the establishment of a publicity department for the United Steel Companies, Limited.

Mr. Robert Crichton, lately vice-chairman of the Scottish Iron and Steel Company, Limited, has accepted a seat on the board of the United Steel Companies, Limited, and the position of general manager of the Workington Iron and Steel Branch of that company.

Ex-Provost John Denholm, Greenock, a well-known figure in the shipping world, was entertained to luncheon last week by the shareholders of the Denholm Line Steamers, Limited, of which he is the head, in celebration of his diamond jubilee in the shipping trade. A model in silver of the first vessel which he owned was presented to Mr. Denholm.

Mr. John Cecil Budd and Mr. William Mure have been elected to seats on the board of the British Metal Corporation, Limited, and have been appointed joint managing directors. Mr. Budd is managing director of Messrs. Vivian, Younger & Bond, Limited, metal merchants, London, and a director of the Cornish Tin Smelting Company, Limited. Mr. Mure is also a director of Messrs. Vivian, Younger & Bond, Limited.

At an annual meeting of the Cleveland Scientific and Technical Institution in Middlesbrough, on April 10, Mr. H. B. Toy, chairman and managing director of the British Chilled Roll and Engineering Company, Limited, Haverton Hill, was accorded a hearty welcome by the Members of Council upon his recovering from a recent illness, and was unanimously elected President of the Institution for the ensuing year. Mr. Toy has devoted a considerable amount of his spare time to technical education, and is past-President of the Staffordshire Iron and Steel Institute and the Cleveland Institution of Engineers. His present appointment is therefore very popular.

Mr. Owen William Ellis, who has recently relinquished a post as research engineer to the Westinghouse Electric and Manufacturing Company, Pittsburgh, has taken charge of the metallurgical branch of the Ontario Research Foundation, Toronto. Mr. Ellis, an Englishman, was born at Swindon, Wilts, in 1888, and educated at the Leys School, Cambridge. Graduating in science from Birmingham University in 1914, he was appointed supervisor in the Royal Ordinance factories at Woolwich. In 1917 he was appointed chief metallurgist to the Royal Ordnance Laboratory, and shortly afterwards received the degree of Master of Science. Going to Toronto in 1921, he became assistant professor of metallurgical engineering at Toronto University, and was awarded a Carnegie scholarship the following year. Since then he has been associated with Mellon Institute, Pittsburgh University, and has served also on the Carnegie Institute of Technology.

Wills.

Jackson, W., of Messrs. Dunsmuir & Jackson and the North-West Rivet, Bolt and Nut Factory, Limited ...	£138,928
M'Farlane, H., superintendent, Singer Manufacturing Company, Limited, Kilbowie	£15,652
Thomson, Sir J. W., K.B.E., Leith, manager of the Ben Line of steamers and of W. Thomson & Company, etc.	£143,137

Obituary.

Mr. William Worby Beaumont, the well-known engineer, died in London on April 14 at the age of 80.

The death occurred, on April 8, of Mr. Robert O'Beirne Twycross, of the Scottish Iron and Steel Company, Limited, Coats Iron Works, Coatbridge.

Mr. John Henry Thomas, Tymawr Road, Llandaff North, for nearly 40 years associated with the Evans' Eagle Foundry, Llandaff, was buried at St. Mary's Church, Whitchurch, on April 16.

Mr. W. H. Robinson, who for 18 years was works manager for Messrs. Samuel Fox & Company, Limited, Stocksbridge, and at one period was engineer at the works of Messrs. Steel, Peech & Tozer, Limited, died in Sheffield on April 13, at the age of 65. He retired from active business about four years ago.

The death occurred last week, at Larbert, of Mr. George Rae, general manager of Messrs. Watson, Gow & Company, Limited, Etna Foundry, Falkirk. Mr. Rae, who was well known in local foundry circles, was originally in the employ of the Carron Company. He assumed the position at Etna Foundry about five years ago.

Reports and Dividends.

Herbert Morris, Limited.—Interim dividend on the ordinary shares at the rate of 10 per cent. per annum, less tax.

Howard & Bullough, Limited.—Final dividend on the ordinary shares of 1½ per cent., making 8¾ per cent. for the year.

Monk Bridge Iron and Steel Company, Limited.—Net profit for 1928, without allowance for depreciation, £2,129, reducing the balance at debit of profit and loss account brought in to £140,062.

Harland & Wolff, Limited.—Balance at credit of profit and loss account of £299,558, including amount brought in (£95,203); dividends on first cumulative preference shares, £192,000; carried forward, £107,558.

Babcock & Wilcox, Limited.—Net profit, £734,902; brought in, £125,361; preference dividends, £14,952; ordinary dividend of 15 per cent., tax free, £644,947; to reserve, £50,000; to pension fund, £32,000; carried forward, £118,363.

The Glasgow Corporation, in accordance with a recommendation of the Tramways Committee, have placed an order with Messrs. Bolckow, Vaughan & Company, Limited, for 2,000 tons of steel tramway rails.

"SERVICE BCM/GX FIRST"

IT IS TRUE THAT

as Professor Boswell says in his "British Resources of Refractory Sands"—

"The United Kingdom can be entirely independent of Foreign Supplies" and that
"Much of the Transport of Sands about the country for metallurgical purposes is unnecessary."

The first remark is justified in the light of results obtained by Steel Founders using

YORKSHIRE SAND

and the second remark aptly describes our policy of maintaining Sand supplies in many districts—as near to our customers' works as possible, so as to avoid heavy freight charges.

If you are users of Moulding Sands send us an enquiry, we are always pleased to quote.

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THE GENERAL REFRACTORIES CO., LTD.

SHEFFIELD.

Telephone: 22311.

Telegrams: "GENEFRAX, SHEFFIELD."

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Trading in Cleveland iron during the week current has been confined mostly to transactions on forward account covering the end of May or early June. Prompt business is at present difficult, owing to depleted stocks and restricted outputs at Tees-side furnaces. Happily, in one respect the situation is easier this week. Coke supplies are more plentiful. The export demand for fuel has fallen away, and not only are supplies to the works more abundant, but prices are easier. In the meantime, it is satisfactory to learn that an early alleviation of existing conditions of a shortage of supplies is promised, preparations being already in progress for the restarting of additional furnaces in the district, and this movement affords an indication of the improved economic situation in the pig-iron industry. That the export position is also rapidly improving is confirmed by the returns of shipments to date, the tonnage for the first 16 days of this month being 20,670, compared with 12,758 tons to March 16. Officially, prices are unchanged, current quotations ruling as follow:—No. 1 Cleveland foundry iron, 71s. per ton; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; No. 4 forge, 67s. per ton. These prices are being paid for June-July deliveries to home works, but foreign business is limited.

The hematite section on the North-East Coast continues satisfactory, makers having no difficulty in disposing of present outputs, of which larger quantities could be readily absorbed, while prices remain firm, and neither producers nor second-hands are inclined to accept less than 74s. per ton for mixed numbers and 74s. 6d. for No. 1 quality. On the North-West Coast quotations are also firm, Bessemer mixed numbers remaining at 74s. per ton at works.

LANCASHIRE.—Foundry pig consumers in this area continue to withhold fresh contract commitments, and for the present business is on a restricted scale. The price position shows very little alteration, Staffordshire and Derbyshire makers continuing to quote 73s. 6d. and 71s. per ton respectively for delivery to local works, with Scottish at about 90s.

THE MIDLANDS.—Although comparatively quiet at the moment, business in local markets for pig-iron is expected to show an early expansion in demand, especially as there are signs of better conditions for ironfounders in the Midlands. The minimum zone prices are still being quoted in this area. Derbyshire No. 3 is 72s. 6d., Northants No. 3 69s., and North Staffordshire No. 3 75s., delivered local stations. No. 1 grade is at between 4s. and 5s. per ton extra. Scottish qualities are quoted 93s. 6d. to 94s., also delivered.

SCOTLAND.—Some of the local engineering founders are well booked up with orders and have covered their pig-iron requirements for some months ahead. The light-castings founders, on the other hand, are exceedingly quiet, and the outlook is not very promising. The current quotation for No. 3 Scotch foundry pig continues firmly maintained at 72s. 6d. per ton basis f.o.t.

Finished Iron.

As foreshadowed in recent reports, prices for crown iron have advanced, and good makes are now at £10 per ton. From outside sources £9 10s. and up is still being quoted. This advance is due mainly to the increased costs of raw material, and to some extent, also, to the improved demand. Contrary to expectations, no change was made at the quarterly meeting in the price of Staffordshire marked bars, and the figure of £12 at works still obtains. This level has now been operative for twelve months. The demand for this grade of iron keeps up to a fair standard, and the works are well occupied. There is no improvement in the demand from local works for nut and bolt iron, which is offered at £9 to £9 5s. per ton, and none is likely while foreign iron can be obtained so cheaply.

Scrap.

Consumptive demand for most descriptions of foundry scrap material continues still somewhat below the average, and on Tees-side the market for heavy cast iron is very quiet, 62s. 6d. per ton being the best figure obtainable for ordinary, though good machinery quality in handy sizes realises 66s. In the Midlands heavy cast-iron scrap is in good demand at 70s. delivered locally, with light cast-iron scrap scarce at 60s. delivered. In the Scottish markets machinery cast-iron scrap suitable for foundries is difficult to dispose of at 73s. 6d. to 75s. Ordinary heavy cast-iron scrap to the same specification is quoted at 67s. 6d., and for cast-iron railway chairs 68s. 6d. to 70s. Light cast-iron scrap is at around 66s. 3d., with cast-iron firebars at 63s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Steel.

At Sheffield this week a fair volume of business is reported in the market for steel, with basic billets still the chief item of activity. The Billet Association has raised the minimum quotation for all classes of hard basic billets by 7s. 6d. per ton, and the increased figures are being readily paid. Quotations: Basic billets, soft, £6 15s.; medium, £8 2s. 6d.; Siemens acid billets, £8 15s. to £9; steel hoops, £9 5s. to £9 15s. Wire rods, soft basic, £7 12s. 6d.; hard, £10 10s.; acid, £12 to £12 10s. High-speed steel, 18 per cent. tungsten, 2s. 9d. per lb.; ditto, 14 per cent., 2s. per lb. In the finished-steel departments the export demand is still slow, although recently a certain amount of business was transacted for the Far-Eastern and Indian markets. The tin-plate market has been a little more active, and the tone has, in consequence, improved. Prices vary a little according to the condition of the order books, but generally recent advances are well maintained.

Metals.

Copper.—The position in the market for warrant copper, though still erratic at times, bears a fairly confident aspect, with prices on the whole distinctly inclined to a firmer tendency. This attitude has been inspired by prominent buyers entering into some important short commitments, and took place in the face of the weakness reported in American advices, which goes to prove that the technical position, as pointed out recently, is not unsound in spite of the heavy liquidation which has recently taken place.

Closing quotations are:—

Cash.—Thursday, £79 5s. to £79 10s.; Friday, £77 5s. to £77 7s. 6d.; Monday, £77 10s. to £77 15s.; Tuesday, £77 15s. to £78; Wednesday, £77 10s. to £77 12s. 6d.

Three Months.—Thursday, £77 to £77 2s. 6d.; Friday, £74 10s. to £74 15s.; Monday, £74 10s. to £74 12s. 6d.; Tuesday, £74 15s. to £75; Wednesday, £74 12s. 6d. to £74 15s.

Tin.—Values of standard tin at last week's closing markets declined to under £200 per ton, which is the lowest point touched since 1923. In that year the metal fell to £176 5s., and recovered later to £240. Since then it has been as high as £321 per ton. In explanation it may be noted that in this country and on the Continent the demand has been poor, and consumers generally have maintained an attitude of reserve and are inclined to await further developments before entering into fresh commitments.

Official closing prices:—

Cash.—Thursday, £204 5s. to £204 10s.; Friday, £199 15s. to £200; Monday, £198 5s. to £198 10s.; Tuesday, £202 5s. to £202 10s.; Wednesday, £203 7s. 6d. to £203 10s.

Three Months.—Thursday, £205 5s. to £205 10s.; Friday, £200 5s. to £200 10s.; Monday, £200 5s. to £200 10s.; Tuesday, £204 5s. to £204 10s.; Wednesday, £205 5s. to £205 10s.

Spelter.—Although buying has not been very active of late, there does not appear to be any decrease in the actual consumption, and the opinion is generally expressed that consumers are at the moment working on very slender margins, so that, although conditions may be dull at the moment, an increase in the volume of buying may be anticipated in the future.

Daily quotations are:—

Ordinary. — Thursday, £26 17s. 6d.; Friday, £26 13s. 9d.; Monday, £26 13s. 9d.; Tuesday, £26 11s. 3d.; Wednesday, £26 6s. 3d.

Lead.—There has been some revival of activity in the lead market, but, on the whole, consumers are content to await further developments, and are therefore holding off as much as possible. With regard to the future, since it is likely that supplies from Mexico will be hampered, a shortage of metal in the near future is not unlikely.

Prices have been:—

Soft Foreign Prompt.—Thursday, £24 16s. 3d.; Friday, £24 16s. 3d.; Monday, £24 17s. 6d.; Tuesday, £24 15s.; Wednesday, £24 13s. 9d.

Students' Corner

Q.—Why should the sand be dried and the oil and water emulsified?

A.—Some considerations in pre-drying the sand are as follows:—The sand as it lies inside or outside foundries does not always contain the same amount of moisture. This is especially so when it is exposed to the elements, inducing a variation of moisture, which alone will upset regularity in mixing. Experience has shown that emulsified oil mixes with the sand much better, and produces a stronger and a better core. Moisture should not exceed 5 per cent.

Q.—Are oil sand cores as permeable and porous as naturally-bonded sand cores?

A.—They are much more permeable and porous than a natural-bonded sand core, which is chiefly due to the purity, cleanliness and uniformity of the grain size.

Q.—In what way are oil-sand cores superior to natural or clay-bonded cores?

A.—For light or medium thickness castings, they are more permeable, stronger, require less roding, or sprigging, less venting, less blacking, also the sand crumbles, and runs freely from the castings when dressing.

Q.—Are oil-sand cores suitable for heavy thick castings in iron and steel?

A.—Within limits, oil-sand cores are quite suitable for thick castings in iron and steel, but should be made from high-grade fine silica sand. Fine silica sand can be obtained with about 90 per cent. silica content, which is far superior to sea, or beach, sand; moreover, the grains are much finer and cleaner than sea sand. The limit for this type of core is reached when the resinous bond of the core is burnt out before the metal has solidified. When this occurs, the core is either distorted to a more or less shapeless mass by the pressure of the fluid, and the prolonged high temperature, that the core crumbles and floats on the molten metal and may be carried towards the top of the casting. Consequently, it would be unwise to set a core at the bottom of a deep mould unless the metal thickness would permit freezing in a short time.

Q.—Do coarse or fine grains make an equally strong core, and which is the more permeable?

A.—Fine grains will make a stronger core than coarse grains, due to the increased number of contacts, providing that the binder is efficiently mixed and covers each grain of sand with a film. The porosity in both sands is the same, but the gases would escape slightly easier from the coarse grains, due, of course, to a little less friction during the passage out when the castings are being poured.

Q.—Would not fine and coarse grains of sand mixed produce a stronger core?

A.—Probably, but in that case strength is obtained at the expense of porosity and permeability—two very desirable qualities in a core made from either silica or clay-bonded cores.

What Sirocco Service means to you

Submit your Fan Problems to us.

When you instal a

TRADE SIROCCO MARK

FAN

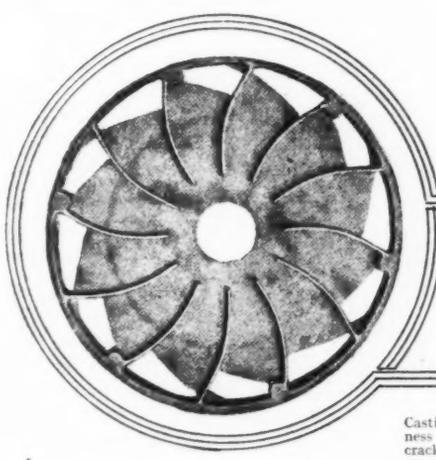
It means that you have the knowledge and experience gained from thousands of different Fan applications brought to bear upon your particular problem. We are equally interested in the efficient working of your Fan Installation and our Engineers are always ready to advise you how to obtain the best results.

DAVIDSON & CO. LIMITED.
Sirocco Engineering Works.
BELFAST

PRACTICAL APPLICATIONS OF NICKEL CAST IRON

5

IMPELLERS, FANS, INTERMEDIATE BLOWER CASES, Etc.



PLAIN IRON		NICKEL IRON	
T.C.	3.5	T.C.	3.4
Si	2.6	Si	2.3
Ni	nil	Ni	0.75

Castings with light sections required to be machinable, adjacent to heavy sections which must be dense and strong. Such castings have a tendency to crack at the junction of the light and heavy sections.

Castings showed openness and tendency to cracking. When silicon was reduced they gave machining trouble.

By reducing silicon and adding nickel, sound, dense castings, machinable in all sections, were regularly obtained.

THE BUREAU OF INFORMATION ON NICKEL, LTD

2, METAL EXCHANGE BUILDINGS
LONDON, E.C.3

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	77	10	0
Three months	74	12	6
Electrolytic	84	0	0
Tough	80	10	0
Best selected	81	0	0
Sheets	112	0	0
India	98	0	0
Wire bars	84	12	6
Do. May	84	12	6
Do. June	84	12	6
Ingot bars	84	12	6
H.C. wire rods	86	5	0
Off. av. cash, March	89	4	4¼
Do. 3 mths., March	90	11	0
Do., Sttlmnt., March	89	3	6
Do., Electro, March	98	16	10½
Do., B.S., March	95	9	2
Aver. spot price, copper, Mar.	89	4	4¼
Do. wire bars, March	99	6	7½

Solid drawn tubes .. 15½d.
Brazed tubes .. 15½d.
Wire .. 12½d.

BRASS.

Solid drawn tubes .. 13d.
Brazed tubes .. 15d.
Rods, drawn .. 12½d.
Rods, extd. or rlld. .. 8¼d.
Sheets to 10 w.g. .. 11⅜d.
Wire .. 11½d.
Rolled metal .. 10⅞d.
Yellow metal rods .. 8¼d.
Do. 4 × 4 Squares .. 9d.
Do. 4 × 3 Sheets .. 9½d.

TIN.

	£	s.	d.
Standard cash	203	7	6
Three months	205	5	0
English	203	10	0
Bars	205	5	0
Straits	205	15	0
Australian	205	5	0
Eastern	204	0	0
Banca	208	5	0
Off. av. cash, March	220	17	4½
Do., 3 mths., March	221	15	5½
Do., Sttlmt., March	220	17	6
Aver. spot, March	220	17	4½

SPELTER.

	£	s.	d.
Ordinary	26	6	3
Remelted	25	10	0
Hard	21	10	0
Electro 99.9	29	5	0
English	27	2	6
India	22	15	0
Zinc dust (Nom.)	36	10	0
Zinc ashes	9	0	0
Off. aver., March	27	3	5½
Aver., spot, March	27	1	0

LEAD.

	£	s.	d.
Soft foreign ppt.	24	13	9
English	26	5	0
Off. average, March	25	9	11½
Average spot, March	25	8	2½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	34	5	0
Do. V.M. ex whf.	33	7	6
Rods	42	0	0
Boiler plates	31	0	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	54	10	0
Chinese	37	10	0
Crude	33	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	3	9

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	15	0
45/50%	12	0	0
75%	19	10	0

Ferro-vanadium—
35/50% .. .. ..13/9 lb. Va.
Ferro-molybdenum—
70/75% c. free .. ..3/9 lb. Mo.
Ferro-titanium—
23/25% carbonless .. 11d. lb.
Ferro-phosphorus, 20/25% .. £16 0 0
Ferro-tungsten—
80/85%, c. fr. .. .. 2/10½ lb.
Tungsten metal powder—
98/99% .. .. .. 3/0½ lb.
Ferro-chrome—
2/4% car. £33 0 0
4/6% car. £25 0 0
6/8% car. £23 2 6
8/10% car. £22 17 6
Ferro-chrome—
Max. 2% car. £34 10 0
Max. 1% car. £37 5 0
Max. 0·70% car. £41 12 6
70% carbonless .. .. 1/2 lb.
Nickel—99% cubes, or pellets £175 0 0
Ferro-cobalt .. .. .. 9/4 lb.
Aluminium 98/99% £95 0 0
Metallic chromium—
96/98% .. .. .. 2/6 lb.
Ferro-manganese (net)—
76/80% loose £13 15 0
76/80% packed £14 15 0
76/80%, export £14 10 0
Metallic manganese—
94/96%, carbonless .. 1/6 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten £0 2 0
Finshed bars, 18% tungsten £0 2 9
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares, 3 in. and over .. .. 4d. lb.
Rounds and squares, under ½ in. to ¼ in. .. .. 3d. lb.
Do., under ¼ in. to ⅛ in... 1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. .. .. 3d. lb.
Do., under ½ in. × ¼ in. .. 1/– lb.
Bevels of approved sizes and sections .. .. 6d. lb.
Bars cut to length, 10% extra

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel	4	0	0	to	4	2	6
Bundled steel and shrngs ..	3	15	0	to	4	0	0
Mixed iron and steel					3	15	0
Heavy cast iron	3	6	0	to	3	8	0
Good machinery for foundries					3	10	0

Cleveland—							
Heavy steel					3	3	6
Steel turnings					2	17	6
Cast iron borings					2	13	6
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	2	6	to	3	6	0

Lancashire—							
Cast-iron scrap	2	17	6	to	3	10	0
Hvy. wrought					3	15	0
Steel turnings					2	15	0

Scotland—							
Heavy steel					3	15	0
Cast-iron borings ..					2	15	0
Wrought-iron piling ..					3	12	6
Heavy machinery ..					3	13	6

London—Merchants' buying prices delivered yard.

Copper (clean)	68	0	0
Brass	43	0	0
Lead (less usual draft) ..	21	0	0
Tea lead	17	0	0
Zinc	18	10	0
New aluminium cuttings ..	67	0	0
Braziery copper	60	0	0
Gunmetal	55	0	0
Hollow pewter ..	160	0	0
Shaped black pewter ..	110	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—
Foundry No. 1 .. .. 71/–
Foundry No. 3 .. .. 68/6
Foundry No. 4 .. .. 67/6
Forge No. 4 .. .. 67/–
Hematite No. 1 .. .. 74/6
Hematite M/Nos. 74/–

N.W. Coast—
Hem. M/Nos. d/d Glas. .. 83/6
„ d/d Birm. 90/6

Midlands—
Staffs. common* .. .. —
„ No. 4 forge* .. 71/–
„ No. 3 fdry* .. 75/–
Shrops. basic .. .. —
„ Cold blast, ord. .. —
„ „ roll iron .. —
Northants forge* 65/–
„ fdry. No. 3* .. 69/–
Derbyshire forge* 68/6
„ fdry. No. 3* .. 72/6
„ basic* .. .. —
* d/d Black Country dist.

Scotland—
Foundry No. 1 .. .. 75/–
„ No. 3 .. .. 72/6
Hem. M/Nos. 77/–

Sheffield (d/d district)—
Derby forge 63/6
„ fdry. No. 3 .. 67/6
Lincs. forge 67/6
„ fdry. No. 3 .. 72/6
E.C. hematite 85/–
W.C. hematite 87/–

Lincs. (at furnaces)—
Forge No. 4 .. .. —
Foundry No. 3 .. .. —
Basic .. .. .. —

Lancashire (d/d eq. Man.)—
Derby forge .. .. —
„ fdry. No. 3 .. 71/–
Northants foundry No. 3 .. —
Dalzell, No 3 (special) 100/– to 102/6
Summerlee, No. 3 .. .. 90/–
Glengarnock, No. 3 .. —
Gartsherrie, No. 3 .. .. 90/–
Monkland, No. 3 .. .. 90/–
Shotts, No. 3 .. .. 90/–

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops					11	10	0
Marked bars (Staffs.) f.o.t.					12	0	0
Gas strip					11	10	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0

Steel—							
Ship plates	8	7	6	to	8	12	6
Boiler plts.					10	10	0
Chequer plts.					10	12	6
Angles					7	17	6
Tees					8	17	6
Joists					7	17	6
Rounds and squares, 3 in. to 5½ in.					8	17	6
Rounds under 3 in. to ½ in. (Untested)					7	15	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1½ in. ..					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs.)					11	0	0
Black sheets, 24g.	10	0	0	to	10	10	0
Galv.cor.shts., 24g.	13	7	6	to	13	15	0
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	7	6	to	7	0	0
Billets hard	7	10	0	to	8	2	6
Sheet bars	6	5	0	to	6	10	0
Tin bars	6	5	0	to	6	10	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	10d. to 1/4
Rolled—	
To 9 in. wide ..	1/4 to 1/10
To 12 in. wide ..	1/4½ to 1/10½
To 15 in. wide ..	1/4½ to 1/10½
To 18 in. wide ..	1/5 to 1/11
To 21 in. wide ..	1/5½ to 1/11½
To 25 in. wide ..	1/6 to 2/–
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	15.50
Basic	19.76
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.96
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, 9 and 10 ..	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/– to 30/–
„ furnace	21/– to 25/–
Durham and North.	
„ foundry ..	18/– to 19/–
„ furnace ..	17/– to 17/6
Midlands, foundry ..	—
„ furnace ..	20/– and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14 box ..	18/6
„ ..	28×20 „ ..	36/6
„ ..	20×10 „ ..	26/3
„ ..	18¾×14 „ ..	18/9
C.W. ..	20×14 „ ..	15/–
„ ..	28×20 „ ..	33/6
„ ..	20×10 „ ..	21/3
„ ..	18¾×14 „ ..	15/–
Terneplates ..	28×20 ..	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron ..	£6	0	0	to	£7	10	0
Bars, hammered, basis ..	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis ..	£15	15	0	to	£16	15	0
Blooms ..	£10	0	0	to	£12	0	0
Keg steel ..	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63⅓%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
April	18	79	5	0	inc.	30/-
,,	19	77	5	0	dec.	40/-
,,	22	77	10	0	inc.	5/-
,,	23	77	15	0	,,	5/-
,,	24	77	10	0	dec.	5/-

Electrolytic Copper.

		£	s.	d.		
April	18	84	0	0	No change	
,,	19	83	0	0	dec.	20/-
,,	22	83	0	0	No change	
,,	23	83	15	0	inc.	15/-
,,	24	84	0	0	,,	5/-

Standard Tin (cash).

		£	s.	d.		
April	18	204	5	0	dec.	60/-
,,	19	199	15	0	,,	90/-
,,	22	198	5	0	,,	30/-
,,	23	202	5	0	inc.	80/-
,,	24	203	7	6	,,	22/6

Tin (English ingots).

		£	s.	d.			
April	18	204	5	0	dec.	60/-	
,,	19	200	0	0	,,	85/-	
,,	22	199	0	0	,,	20/-	
,,	23	203	5	0	inc.	85/-	
,,	24	203	10	0	,,	5/	

Zinc Sheets (English).

		£	s.	d.			
April	18	34	5	0	No change		
,,	19	34	5	0	,,	,,	
,,	22	34	5	0	,,	,,	
,,	23	34	5	0	,,	,,	
,,	24	34	5	0	,,	,,	

Spelter (ordinary).

		£	s.	d.		
April	18	26	17	6	inc.	3/9
,,	19	26	13	9	dec.	3/9
,,	22	26	13	9	No change	
,,	23	26	11	3	dec.	2/6
,,	24	26	6	3	,,	5/-

Lead (English).

		£	s.	d.		
April	18	26	5	0	inc.	5/-
,,	19	26	5	0	No change	
,,	22	26	5	0	,,	,,
,,	23	26	5	0	,,	,,
,,	24	26	5	0	,,	,,

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 6
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 9	100 0	100 0	110 0½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 9	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	—	—	—	—	—	—	—	—	—	—

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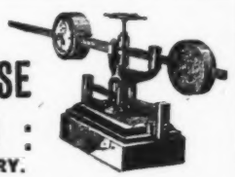

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